Municipal News and Water Works

PUBLISHED MONTHLY BY GILLETTE PUBLISHING COMPANY

CONKEY AVE. AND MADISON ST., HAMMOND, IND., AND 221 EAST 20TH ST., CHICAGO, ILL.

Publishers of

Engineering and Contracting
Municipal News and Water Works
Roads and Streets
Road and Street Catalog and Data Book
Water Works Catalog and Data Book
General Contractors' Catalog and Data Book

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Subscription Price $2.00

Foreign Postage 65c Extra

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Vol. LXXV AUGUST, 1928 No. 2

The Immigration of Research Technicians

"After eight years as engineer and head of the research bureau of the Royal Board of Water Falls in Stockholm, Sweden, Dr. Harold Nordiner is now a consulting engineer for the Westinghouse Electric and Manufacturing Co." He has invented an oscillograph for automatically recording voltage surges on power lines, due to lightning or analogous causes.

Dr. Nordiner's immigration to America is typical of that of hundreds of European scientists and engineers since the end of the world war. Many of our large manufacturing companies have developed great research departments that are constantly growing, and with their growth comes an increased demand for experienced research engineers. It takes no marked prophetic instinct to forecast a steadily increasing flow of research technicians into this country from all the countries of the world, for here is the greatest chance for fortune and for fame.

Since our unexampled prosperity is founded upon the work of our original men, aided by freedom from restrictions to individual enterprise, it follows that the most certain way of accelerating our march toward universal wealth consists not only in training and employing more of our own engineers as research technicians but in attracting to our shores as many of the most brilliant foreign originators as possible.

The other day a celebrated English scientist, speaking about astronomical progress, said that astronomy might almost be called "that American science." Our highly endowed observatories have made so many discoveries in recent years that the astronomers of Europe look enviously upon the instruments that our astronomers possess. Yet, great as our telescopes are, still greater are planned. Miss Proctor, daughter of a celebrated American astronomer, is now engaged in canvassing the country for ten million dollars with which to build a telescope that will make all others seem to it, as Galileo's first little tube with its spectacle lenses seems to the hugest telescope now in use. Who can doubt that with such an instrument there will unfold many a hidden galaxy vastly greater than our own? And with the discovery of countless new star systems there will also come knowledge of their mutual relationship and their common origin.

Most astronomers now believe that the spiral nebulae are "island universes," or galaxies similar to our galaxy that is "bounded" by the milky way. They explain the fact that spiral nebulae decrease in number as the telescope points more nearly toward the milky way, on the hypothesis that star dust in the vicinity of the milky way obscures the vision. But it is not unlikely that the real reason is this: As the axis of Uranus and the axis of the orbits of its moons point toward the sun, so may the axis of our whole galaxy point toward a stupendous star about which our galaxy revolves, and about which other galaxies (the spiral nebulae) also revolve. This hypothesis explains why the number of spiral nebulae increases as the angle from the milky way increases. The building of the Proctor telescope would probably answer this and many other enigmas; and with the answers would come many a piece of knowledge applicable in everyday affairs, leading to greater and greater prosperity. Let it never be forgotten that Newton's theories of the mechanism of star motions under the action of gravitation and centrifugal force stands second to none in the development of man's knowledge of practical mechanics. Remember also that helium gas was discovered in the sun before its existence on earth was suspected, and that helium is now secured as a by-product from gas wells in Texas and is used in place of hydrogen in balloons.

All nature is so intimately interwoven that a discovery in one realm often throws a flood of light upon some obscure fact in a realm so remote that the two seemed forever separated. For example, who would have dreamed that the history of climatic changes could be read in the periodic variation in the thickness of tree rings, and that this variation in turn would give the history of sunspot variation, which in turn would furnish evidence that planets cause sunspots?

The student of the history of science soon becomes familiar with its unfailing economic fruitfulness, but unfortunately this characteristic is not generally appreciated even by educated men. Were it fully appreciated every large manufacturer would have a scientific research laboratory, and small manufacturers would cooperate in financing and operating similar laboratories. There are said to be 1,000 research laboratories now in America, but most of these are doubtless engaged on problems relating solely to the immediate business needs of their supporters. This, of course, is a step in the right direction, but until researchers are also

given free rein to drive the chariots of their imagination wheresoever they will, the greatest fruitfulness of research can not be attained.

Because Europe, particularly in Germany and England, has long been superior to America in the development of pure science it is the part of wisdom not only to read the works of her brilliant discoverers, but to induce many of them to take residence among us.

A Plea for Adequate Rewards for Scientists

The lodestone that attracts the most brains is gold. Sordid as this may appear, history quite clearly indicates its truth.

When gold was most readily secured by conquest, the ranks of the warriors were filled with brilliant men. In fact, most of the ancient thrones were thus founded, along with the houses of the lesser rulers.

When gold was most readily secured by skilled craftsmen, great numbers of bright minds flocked into the profession of art. Grecian art, for example, did not flourish so greatly because art was then adolescent, but because it paid well to be a great artist. And again in the pre-Victorian age when opulence became common, portrait painters flourished as they had never flourished before and have never flourished since. De Guerre's invention knocked the profit out of painting; and profit gone, the great portrait painters disappeared. The camera ended their career.

Much of the genius, as well as much of the folly, of the world has been assembled at Hollywood. There the camera has developed a new art that makes the popularity of all previous arts seem small; and coincidentally is bestowing Aladdin fortunes upon the leading artists and business managers alike.

Ever since the "industrial age" was ushered in eight generations ago by the steam engine, manufacturing has offered great prospects of great profit, and has vastly enriched thousands of men. Consequently many of the ablest men of the world have gone into manufacturing. It is this high order of manufacturing ability that accounts largely for America's phenomenal prosperity. By the side of H. G. Wells' phantasmal puppets that are presumed to typify the successful manufacturer, set real manufacturers like Rockefeller, Carnegie, and Ford, if you wish to see some of the reasons why America is great.

True it is that our greatest manufacturers have always leaned heavily upon the shoulders of inventors and engineers, and they, in turn, upon the shoulders of pure scientists. True, also, that the last named have commonly been so ill rewarded that our whole thesis seems to be belied by that fact. But fame to some men is a reward more prized than wealth. It was fame that drew Newton and Faraday and Einstein into the ranks of the scientists. But for every such genius so drawn, probably a hundred men of equal mental power and assiduity have been drawn into the management of manufacturing enterprises, for to the great majority of men, income still takes precedence over laudation, and a mansion is preferred to a mausoleum.

If so, our plea to such men becomes a plea for better financial rewards to the men of pure and applied science. An enlightened self-interest should teach the wealthy manufacturer that greater income for the original men of science and engineering will result in a more eager thronging of their ranks by the geniuses of the world, and this, in turn, will multiply the profits and the power of the executive geniuses who employ them.

There is evidence that this thought is taking hold of great executives here and there. It is seen first, in the fact that about 1,000 research laboratories are now maintained by American manufacturing companies, and, second, in the fact that here and there an employee in these laboratories emerges with a fistful of gold. Still the path to a general acknowledgment of the wisdom of rich pay for researchers is merely a vague trail through the woods of ignorance, its direction blazed now and again on some tree, but only followed by the keenest eye. No highway yet exists that can be truly called The Highway of Payment in Proportion to Performance.

The True Significance of an America on Wheels

Los Angeles, with a population of one and a quarter million, has more automobiles than the total of four nations having a combined population of two hundred million, namely, Italy, Spain, Russia and Japan. The total motor vehicle registration in Los Angeles is 430,000 in round numbers.

If such statistics lack impressiveness because the comparison is made with countries that are relatively poor, then consider the following totals of registered motor cars:

Germany	422,300
Australia	423,500
Argentina	241,400

The true significance of great motor vehicle registration throughout America lies in the disclosure of the high average incomes of her people. Nearly all our states have at least one motor car per family. Los Angeles county leads all sections, but not by any enormous margin, with one and a third cars per family. In the nations of Europe, few people, other than those classed there as wealthy, own motor cars. Hence, by their standards of wealth, nearly every American is rich. Even by our own standards of a generation ago, most of us are rich.

There is a marked tendency abroad to attribute our prosperity to our natural resources and the world war. The latter aided us not a particle, but really halted our productive increase. The former, namely, our natural resources, is to be found in sufficient abundance in almost every country possessed of large area. Moreover, England has demonstrated that a great manufacturing nation can readily bring to her factories the raw materials of the world as long as her workers remain highly productive. When, through labor union restrictions and socialistic repression of individual enterprise England began to fall behind in per capita productivity, then, and not till then, were loud complaints made as to her paucity of natural resources. Let her once more return to a status of industrial freedom, and it will not be many years before she, too, will be a nation on wheels.

H. P. Gillette

Water and Sewer Developments for the New Town of Westchester, Ill.

Modern Subdividing Methods as Handled Near Chicago

TOWN planning has been evolved from a matter of inadequate first installations and hit or miss additions to the point where everything is amply provided for and built long before the first inhabitants arrive, based on sound engineering principles and experience. Typical examples of this sort of modern planning are to be found in some of the recent subdivisions in the Chicago area, notably in projects where entirely new communities are being built up on land formerly devoted to farming. An interesting example of this kind is found in the future town of Westchester, now being developed near the western edge of Cook County, Illinois, now under development as a new suburban community for Chicago commuters. Not only does the planning involve the town of Westchester, that up to this year was swamps and cornfields, but it involves the village of Broadview, to the east, that already contains a scattered population. A complete modern water works system, a complete storm water sewer system, a complete sanitary sewer system, as well as paving, sidewalks, and street lights, are being installed before homes are built, and rapid transit facilities have been secured for direct express communications with the Loop district of Chicago. Parks and playgrounds, schools, and other facilities have also been provided for in the scheme in order that the town will be developed in a logical manner. All design and construction work have been placed under the charge of a firm of consulting municipal engineers.

This ambitious plan of town development is a good example of modern thought in the matter of subdivisions and town development. Especially interesting are the water works and sewer systems, the data on which, presented in this issue, were secured from the engineers responsible for the work.

Water Supply.—The water is obtained from the city of Chicago, with connection with the 24th Chicago main at Austin Blvd. and Railroad St. The connection is by 12-in. main to a meter vault containing two 8-in. style 3 Trident disk meters. Water is taken to Westchester through a 16-in. main 28,600 ft. long. This main supplies water to the villages of Broadview and Westchester. Storage is provided for by a reinforced concrete underground reservoir of 500,000 gal. capacity and elevated water tank 100,000 gal. capacity, with head of 90 ft. The reservoir and tank are in Broadview. The pumping station at this point has three centrifugal pumps; one 500 gpm. against 160 ft. head; one 1,000 gpm. against 160 ft. head; both driven by 40 hp. electric motors. In addition is one pump rated at 500 gpm. against 160 ft. head, combined gas and electric driven, for standby. The total present capacity

Sewer Excavation at Westchester

of the system with present installation will be 3,000,000 gal. per day, which is estimated to be ample for 20 years with only minor additions, allowing a consumption of 120 gal. per capita per day. In future a booster station can be built in the village of Oak Park which will increase the water supply to 6,000,000 gal. per day. This supply should furnish water to the estimated 50,000 people in Broadview and Westchester in the future at the average daily rate of 120 gal. per capita.

To carry the water to the reservoir, 22,860 ft. of 16-in. pipe was laid between the Austin Blvd. connection and the pump house and reservoir, as well as 5,800 ft. between the pump house and the elevated tank which has a capacity of 100,000 gal. The head is 90 ft. from the main to the bottom of the tank. No arrangement has been made for the treatment of the water.

Distribution.—Distribution in the system is from a 12-in. main along Roosevelt Rd. to Broadway, then south on Broadway to 22nd St., then west on 22nd St. to the western limits of Westchester, or approximately through the center of Westchester. The water rate is to be 6.8 ct. per 1,000 gal. from the Chicago mains, plus 4.5 ct. for maintenance and operation, plus 2.0 ct. for attendance, making the total estimated cost of delivered water 13.3 ct. per 1,000 gal.

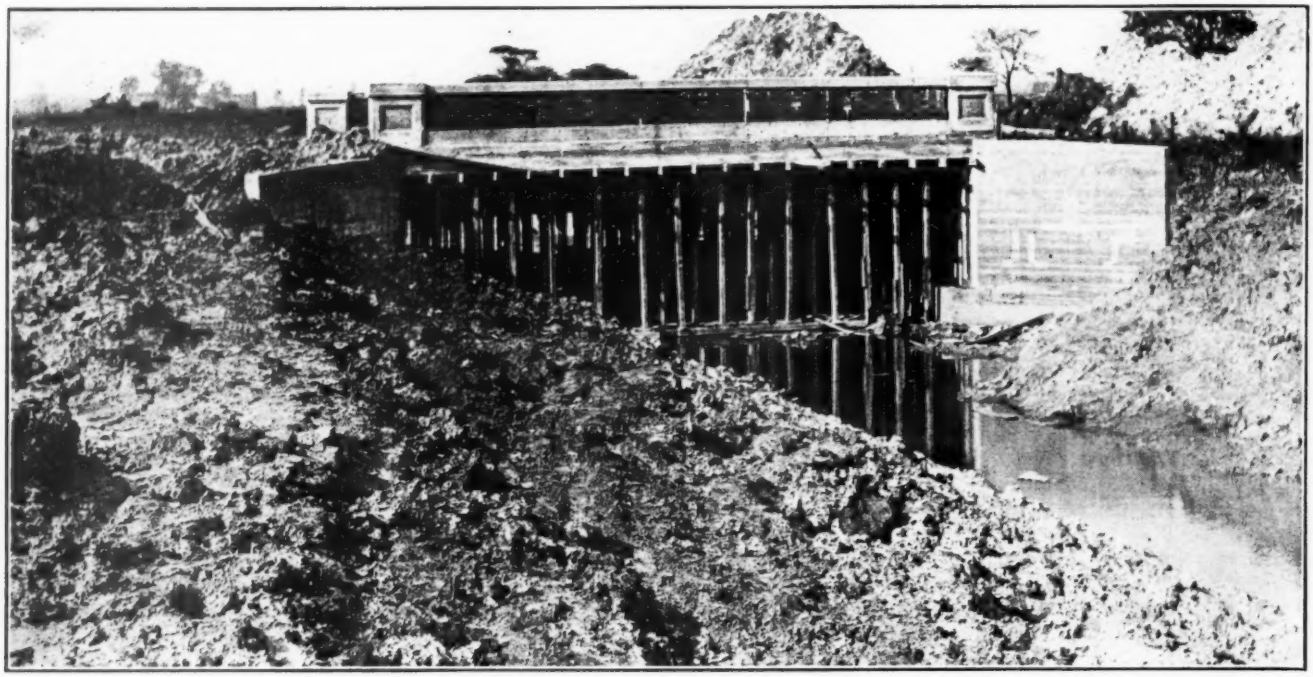
Sanitary Sewers.—The sanitary sewers were designed on a basis of a proportion of runoff using formula $R=CA^{3/4}$. The coefficient in this formula was taken as 0.05 and the coefficient n in Kutter's formula taken as 0.015, as vitrified salt glazed sewer pipe was to be used throughout the systems. An equipment flow was figured for comparison as follows: Figuring 7 lots per acre and 7 people per lot, or roughly, 50 people per acre, the runoff formula shows 450 gal. per 1,000 minutes per person, which is ample to provide for infiltration, house drainage, and a factor of safety to allow for storm water entering the sanitary system. Ample design for infiltration and accidental roof connections has proven to be good practical policy in the Chicago area, due to extreme difficulties encountered in administering separate systems.

The greater portion of Westchester is flat, which necessitated minimum grades and therefore larger sized sewers than would be required in more rolling country. A minimum sewer size of 10 in. was adopted, however, and as may be seen from the distribution table, a larger percentage of the sanitary sewers are of this minimum size.

Due to the flat grades it was found necessary to include a sewage pump pit for the largest system designed to

Table I—Distribution and Fire Systems Laid and Under Contract to Date

	16 in.	12 in.	8 in.	6 in.	4 in.	Hydrants	10 in.
Supply line	28,600	.....	.....	.....	.....	.....	.....
Roosevelt Rd. system	.....	10,800	26,700	83,800	.....	285	.....
Second terminal addition system	.....	.....	4,035	8,455	.....	29	.....
22nd St. addition system	.....	1,340	3,777	7,846	.....	36	.....
Woodlands and Highlands system	.....	5,330	10,075	22,900	940	97	1,275
Totals	28,600	17,470	44,587	123,001	940	447	1,275



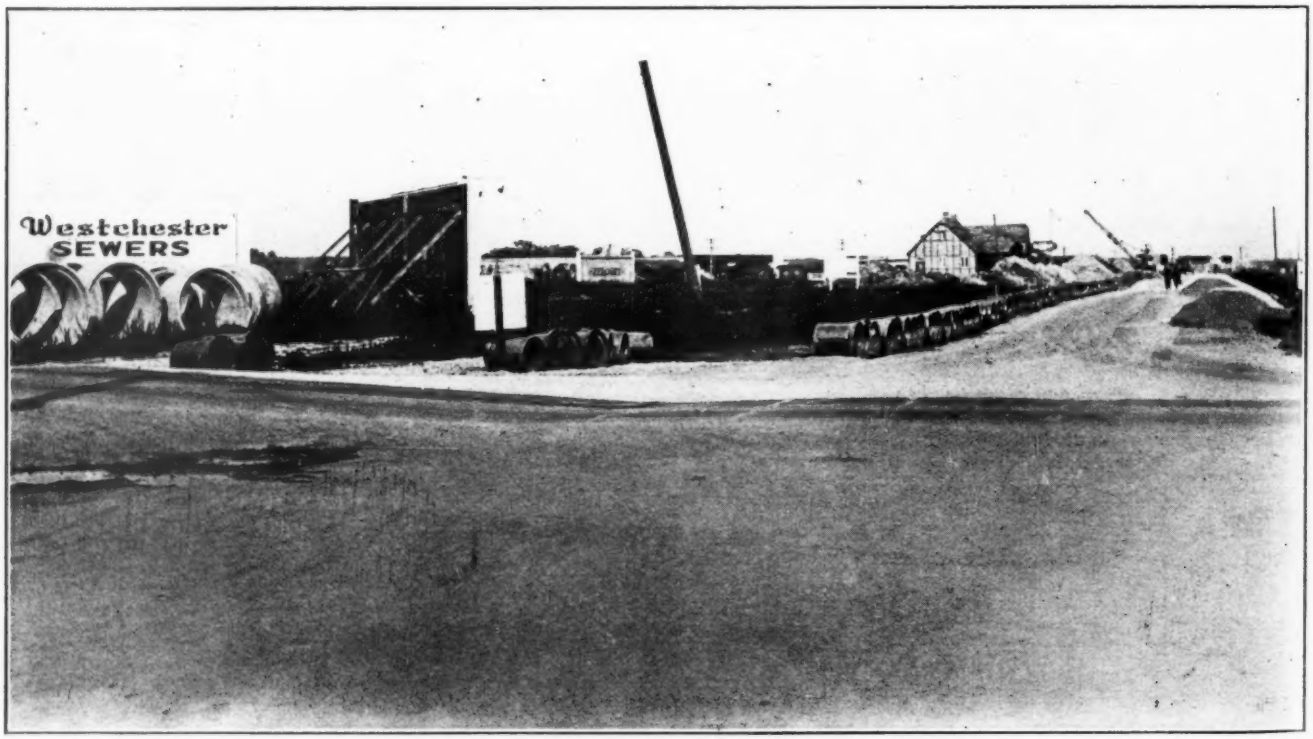
New Bridge Over Waterway in Park

date in order to discharge the sewage at times of high water in the interceptor. The outlet for this system is at the east limits of Westchester on Roosevelt Rd., at which point the sewage is discharged into a 60-in. sewer operated by the Sanitary District of Chicago. The sewage pump pit was built at this corner and serves to lift the sewage into this 60-in. sewer whenever it begins to back up into the Westchester sewage system. The pumps in the pit are automatically operated by a float which also operates sluice gates to prevent the flow from reversing. The distribution of sewer sizes on projects now under contract is shown in Table II.

Sewage Pumps.—Two Yeomans vertical dry pit non-clogging centrifugal sewage pumps each having capacity of 1,000 gpm. at a total head of 25 ft. were installed in the pit. The use of Presstite joints reduced infiltration to the allowable limit of 5,000 gal. per 24 hours per mile of sewer on work built to date.

Soil conditions for the most part were favorable, with stiff clay in the soil in most places. In a few of the deeper lines quicksand was encountered but very little difficulty was experienced on account of this. The average cut for sanitary sewers was about 9½ to 10 ft.

Storm Sewers.—The design of the



View Taken at Northeast Corner of Mannheim Rd. and Roosevelt Rd.

Constructing Sewer in Gladstone Ave.

storm sewers was based on the formula $R=CA^{3/4}$, using $C=70$ and $n=.015$.

In the case of the storm sewer design as with the sanitary sewers the flat nature of Westchester necessitated very flat grades and consequently larger sizes than would be the case were the country more rolling. Storm water, which includes water drained from roofs, and street drainage, is discharged into Addison Creek, which was straightened and deepened as part of the storm sewer project, and Salt Creek, which runs through the southerly part of Westchester. Particular care had to be taken in establishing the grades of the storm sewers to prevent interference of the house connections from the sanitary sewers, with

Table II—Sizes of Sewers

Size	27 in.	24 in.	21 in.	18 in.	15 in.	12 in.	10 in.	30 in.
Roosevelt Rd. system	1,210	2,730	1,300	380	2,530	7,900	47,810	.....
22nd St. system	.....	2,010	4,830	2,500	4,950	4,120	38,860	.....
Woodlands and Highlands system	190	640	.....	1,880	.....	420	20,410	3,200
Second terminal addition system	820	3,280	.....	640	.....	.....	8,310	.....
Totals	2,220	8,660	6,130	5,400	8,480	12,440	115,390	3,200

Excavating for New Waterway in Park

the storm sewers. Several plans were developed and the most economical design as determined from average contract prices in the Chicago area was adopted. Some difficult and expensive features of the largest storm sewer project made the construction interesting. It was found to be necessary to construct an inverted syphon in the 84 in. outlet line on Roosevelt Road in order to leave clearance for a future track extension of the C. W. & W. R. R. The sewer at this point was depressed 11 ft. for a distance of 116 ft. the total length of inverted syphon being 196 ft. This structure was built

Construction View of Storm Sewer Operations at Westchester

of monolithic concrete and consists of two conduits.

Another portion of the sewer was laid through a deep peat bog and it was found necessary to support this line on a trestle structure which rests on piles.

Approximately 1,000 ft. of 72 in. storm sewer and the same length of 21 in. and 15 in. sanitary sewer were built in this manner.

Construction Notes.—At the point where the water main leading to the project crossed the DesPlaines River, a small stream normally about 50 ft. wide and 2 or 3 ft. deep with a very sluggish flow, a cofferdam of double rows of sheet piling was first constructed, and excavation by hand then produced a trench in which the pipe could be laid. Work was done in winter in order that the men could work from the ice. The main was laid 3 ft. below solid bottom at this point. Street crossings in Oak Park were negotiated by tunneling and then filling the tunnels with concrete by hand methods. This rather expensive method of putting the main under streets avoided interruption to traffic. On trenching for the main, the usual cut was about 7 ft., except at railroad crossings where the cut was about 12 ft. in order to provide greater cover. An Austin trencher, a Parsons backfiller, and a crew of about 8 men resulted in an average output of from 600 to 700 lin. ft. per 8-hour day. Pipe was handled with a chain block on a tripod. Pipe was distributed along the trench in the course of delivery and no rehandling was involved except for laying it in the trench. It is interesting to note that fire hydrants were placed at intervals of 330 ft. throughout the distribution system. The average depth of cover in the distribution system was 5½ ft. The trenching and pipe laying methods were the same.

Storm Sewers.—The dredging of the main channel of Addison Creek was done with draglines and power shovels, the latter loading into dump wagons drawn by tractors. The channel of the stream was corrected, to provide better runoff, and the old channel was filled with material excavated from the new channel. The total excavation was approximately 60,000 cu. yd., mostly clay. A concrete revetment wall was laid on one curve, involving 210 cu. yd. of reinforced 1:2:3½ concrete.

The work was designed and was constructed under the supervision of Consoer, Older, and Quinlan, Consulting Engineers, Chicago, with Geo. O. Consoer and H. Kent, Jr., in charge of design, and Arthur W. Consoer, Wm. G. Mawhinney, Horace H. Smith, J. A. McFadden, and C. A. Case in charge of construction. Concrete pipe was furnished by the Independent Concrete Pipe Co., most of the Westchester pipe work was done by the L. E. Myers Co., Chicago, contractors, and other contractors were responsible for various supplementary contracts. The elevated tank was constructed by the Chicago Bridge & Iron Works. The main from the Chicago stub to the distribution system was laid under sub contract by Mills & Son, Contractors.

Table III—Storm Sewer Distribution System

	84 in.	72 in.	42 in.	36 in.	33 in.	30 in.	27 in.	24 in.
Roosevelt Rd. system	1,470	1,430	.....	.....	310	1,850	1,990	3,150
Second terminal addition system	.....	.....	.....	.....	.....	.....	.....	.....
22nd St. system	.....	.....	1,260	1,170	2,130	3,310	5,130	1,640
Woodlands and Highlands system	.....	.....	340	.....	.....	.....	.....	.....
Totals	1,470	1,430	1,600	1,170	2,440	5,160	7,120	4,790

	21 in.	18 in.	15 in.	12 in.	48 in.	54 in.
Roosevelt Rd. system	6,000	8,700	14,100	27,400	.....	.....
Second terminal addition system	.....	5,310	2,700	2,650	.....	.....
22nd St. system	2,140	8,050	16,620	20,940	1,550	.....
Woodlands and Highlands system	.....	1,820	6,660	16,560	660	920
Totals	8,140	23,880	40,080	67,550	2,210	920

Removing Sediment with Dynamite

The accumulation of mud and other sediment, which largely decreases the usefulness of waterways and of ponds used for water supply, has always presented a problem and involved considerable expense in restoring capacity.

However, an easy and comparatively inexpensive method was resorted to by the North American Cement Corporation at its Howe Cave, N. Y., plant. Dynamite was used to remove mud which had accumulated at the intake and over a distance of about 300 ft. toward the center of the pond. The filling in had changed the course of the intake channel and greatly reduced its capacity. Therefore blasting was done to straighten out the intake channel and to increase its depth toward the deeper part of the pond.

About 150 to 175 ft. of the line of the new channel was loaded by hand in about 2 ft. of water, the blaster working from a flat bottom boat. On account of the nearness of the plant buildings and the possibility of the water transmitting the shock of explosion to the plant, extra heavy loadings were avoided, and four separate shots were used in excavating the first 300 ft. But the load was gradually increased as the distance from the intake was increased and the work was carried toward the deeper water.

A spacing of 18 in. in a single line of holes was used for the entire length of the channel. Near the intake two cartridges were loaded per hole, while the loading was increased to four cartridges in the deep water.

The bottom of the pond was deep, soft mud except for about 50 ft., near the intake, which was clay.

Scarcely any vibration from the blasts was felt at the plant and the power house.

Recent Developments in Application of Chlorine in Water Purification

An Outline of the Progress in 1927-28

By L. H. ENSLOW

Research Engineer, The Chlorine Institute, Inc., 30 East 42nd St., New York City

THE practice of applying chlorine to the raw water or the coagulated water at some point ahead of the filters has received marked impetus during the past twelve months.

It is increasingly evident that in many instances the sources of supply of raw water are becoming so polluted with sewage as to make it impossible to depend entirely on coagulation and mechanical filtration. Pre-chlorination has in several instances been effectively applied to relieve the strain on the filtration process by reduction of the bacterial load on the filters. Final or post-chlorination has been reduced and in conjunction with pre-chlorination can be considered primarily as a factor of safety. Pre-chlorination is receiving increasing attention also because effective purification may be had without the necessity of maintaining residual chlorine in the filtered water to the extent otherwise considered advisable for a high degree of safety. Algae growths, so frequently a disadvantage in coagulation or settling basins, seem to have been effectively reduced or controlled by chlorination of the raw water. Filter runs have been materially increased, wash water consumption reduced, and the general condition of the filter beds has been improved. In at least one instance the filters have produced a sparkling effluent which prior to pre-chlorination could not be procured. It appears that chlorination ahead of the filters is effective in reducing the "slime" on the sand grains and thus the filters are more effectively washed. The occurrence of mud spots, mud balls, and breaks or cracks in the sand bed has been minimized.

With some grossly polluted waters, putrefaction and liquefaction of the deposited sludge in the coagulation basins sometimes results in fouling of the incoming fresh water and eructations of sludge from the bottom of the basins. It seems that pre-chlorination is effective in retarding this putrefactive action; basin washing is cut down and the taste of the water improved.

Several instances have been reported in which reduction of coagulant has resulted from pre-chlorination. This advantage, however, can not be predicted unless the water is known to contain iron, and an actual trial is necessary to determine in each case what value pre-chlorination as a coagulant saving process may possess.

Recent Results from Pre-Chlorination at Various Places.—It should be pointed out in the beginning that the pre-chlorination data very difinitely support the conclusions of H. W. Streeter[1] and associates that filters will not produce an effluent meeting the Treasury Department Standard when the raw water contains many more than 60 B. Coli per c. c.

Sandusky, Ohio: (Lake Erie Water).[a] —O. F. Schoepfle, Chemist in Charge at the Sandusky plant began pre-chlorination of raw water in May, 1926, with the sanction of the Ohio State Department of Health. Progress reports are included in the 1926 and 1927 Proceedings of the Ohio Water Purification Conferences. The outstanding results have included longer filter runs, algae reduction, improved coagulation, reduction of chemical costs and improved filter effluents. Fig. 1 graphically presents the bacterial efficiencies secured and Fig. 3 indicates the maximum B. Coli content of the filter effluents with and without pre-chlorination. The reduction in monthly averages for B.

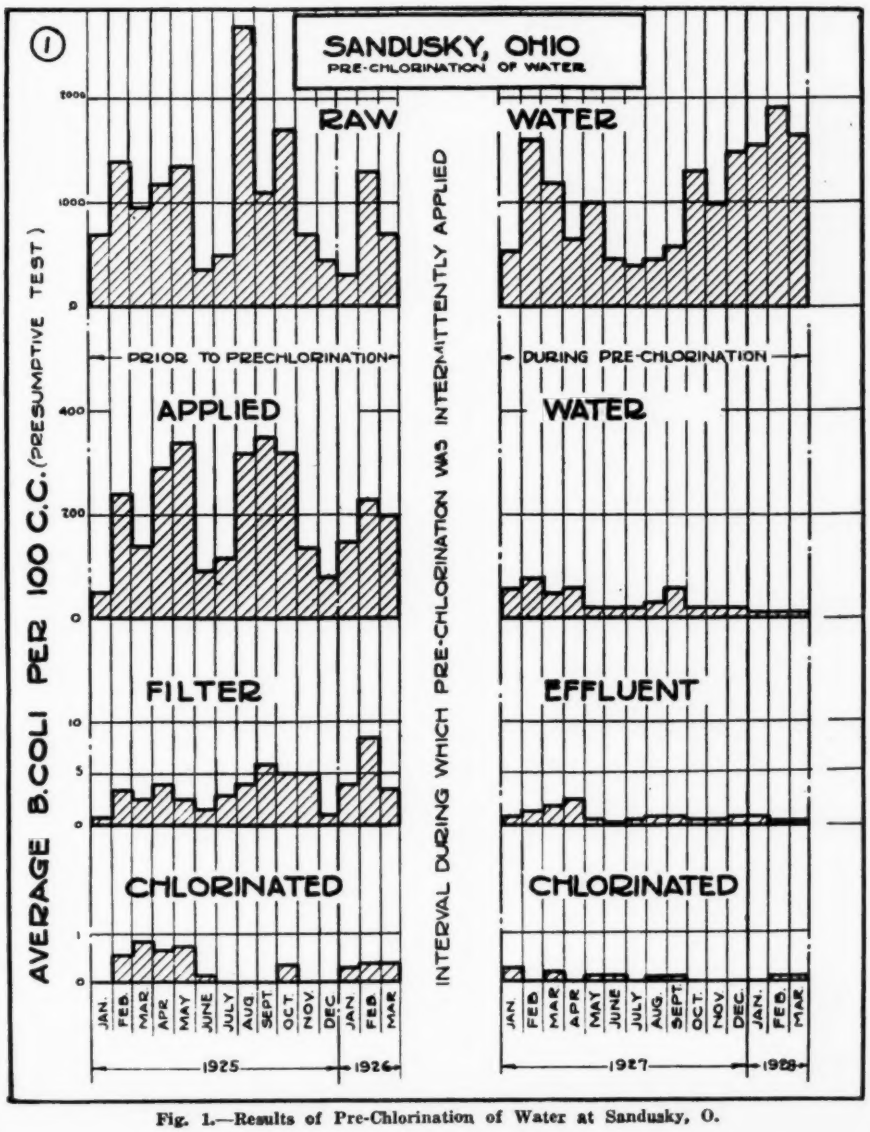


Fig. 1.—Results of Pre-Chlorination of Water at Sandusky, O.

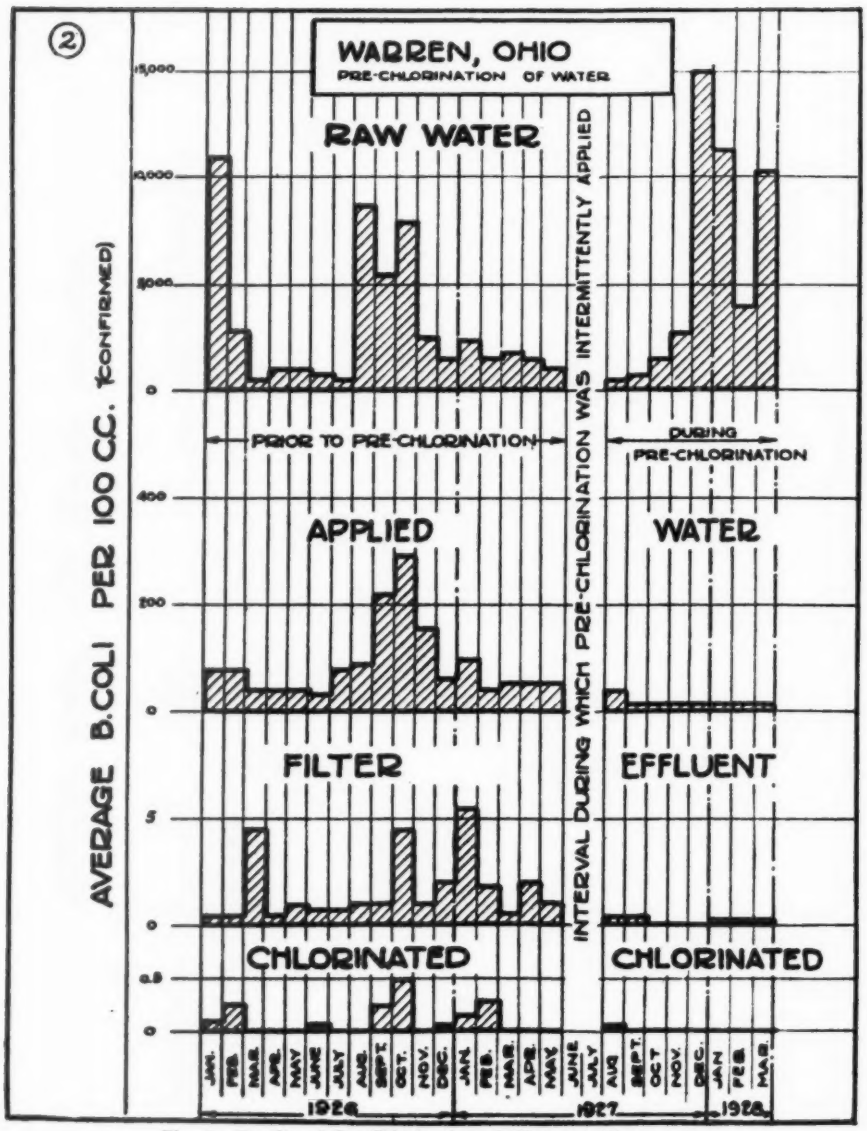


Fig. 2.—Results of Pre-Chlorination of Water at Warren, O.

Coli is of interest, but of greatest interest is the elimination of the spasmodic presence of high coli content in the effluent occurring prior to pre-chlorination as shown in Fig. 3. This effect is of far greater importance than a reduction of the average figures. The average pre-chlorination dosage at Sandusky during 1927 was only 0.37 parts per million and no attempt was made to carry residual chlorine through to the filters. Post-chlorination dosage was 0.32 parts per million, a total of 0.69 parts. For short periods residual chlorine was carried through to the filters without harmful effect and the work is being continued to determine the advisability of maintaining residual chlorine on the filters. During pre-chlorination the filter effluent passed the Treasury Department Standards and post-chlorination merely increased the factor of safety.

Warren, Ohio: (Mahoning River Water).[a]—P. J. O'Connor, Superintendent of Filtration, began pre-chlorination of raw water at Warren, O., filter plant in July, 1927. Detailed results will appear in the 1927 Proceedings of the Ohio Water Purification Conference. The results indicate the great value of pre-chlorination in plants which must handle a water subject to rapid and wide fluctuations in basterial content. The benefits derived include a 33 per cent reduction of coagulant otherwise required to relieve the filters of the high bacterial load, algae reduction, and increase of approximately 20 per cent in length of filter runs. It has been possible to secure a filter effluent which meets the Treasury Department Standard continuously during pre-chlorination. The pre-chlorination dosage was on the average 0.75 parts per million which produced an applied water on the filters containing from a trace to 0.1 p.p.m. residual chlorine. The post chlorination dosage has been reduced from the former figure of 0.35 p.p.m. to 0.23 p.p.m. making a total chlorine consumption of approximately 1.0 p.p.m.

Such a reduction in the final chlorine application is of importance at Warren where the water is pumped directly into the distribution system. There is now a greater factor of safety and less chance of chlorine tastes appearing in the system.

The bacterial results secured during periods prior to and during pre-chlorination are shown in Figs. 2 and 3. Fig. 3 is of particular interest in that it indicates the maximum B. coli content of the filtered water during each month and presents a fair picture of the considerable added safety secured through pre-chlorination which the average B. coli content per month fails to disclose.

Kansas City, Kansas: (Missouri River Water).—L. B. Mangun, Chemist in Charge at the Kansas City, Kansas filtration plant began pre-chlorination of raw water in July, 1927. A detailed paper covering the results was read at the 1928 Kansas Water Operators School at Lawrence, Kan.

Mr. Mangun has not found that pre-chlorination has enabled him to reduce the coagulant dosage and the data so far available indicate no appreciable reduction in wash water. The chief ends sought and accomplished were reduction of bacterial load on the filters, algae reduction, and improved quality of effluent. Figs. 4 and 5 show graphically the effectiveness of pre-chlorination with respect to the average and maximum coli content of the filtered water for each month prior to and during pre-chlorination.

The chlorine dosages applied to the filter effluent and the raw water are shown prior to and during pre-chlorination in Fig. 5. One point worthy of note is the change in total chlorine required with summer and winter conditions. During the cooler months the average total chlorine requirement of 0.68 p.p.m. has been but slightly more than the average of 0.60 p.p.m. formerly required for post-chlorination alone. Mr. Mangun believes from the data already available that the double chlorination practice will increase the total chlorine consumption on an average for the year of approximately .50 per cent or less.

During the summer months no residual chlorine reached the filters when the pre-chlorination dosage averaged from 1 to 1.33 p.p.m. During the winter with dosages of 0.34 p.p.m. to 0.49 p.p.m. residual chlorine reached the filters and occasionally appeared in the effluent without harmful effect to the filters having been observed

An important feature has been the reduction of the residual chlorine maintained in the final water following post-chlorination with continued satisfactory sterilization insured. Prior to pre-chlorination a residual of 0.2 p.p.m. was maintained whereas during pre-chlorination 0.08 p.p.m. has been satisfac-

[a] Data from plant reports and published papers analyized and assembled by H. S. Hutton, Wallace & Tiernan Co., Pittsburgh, Pa.

tory primarily because less dependence on post-chlorination is necesasry during double chlorination.

As to the expense of pre-chlorination at Kansas City, Kan., with single chlorination the cost has been 43 ct. per million gallons, and with double chlorination 65 ct. per million gallons.

Hopewell, Va.: (James and Appomatox Rivers Water).—Richard Messer, Chief Engineer, Virginia State Department of Health, has analyzed the data and supplied graphs of the results at the Hopewell filtration plant where J. W. Haller, Chemist in Charge of the filtration plant began pre-chlorination of the raw water early in 1924. (See Fig. 6.)

It is noted that the first effect of pre-chlorination was not beneficial to the filter effluent although a marked reduction in B. coli content of the applied water was promptly secured. During the first few months of pre-chlorination the filters seemed to be unloading gas-producing organisms (presumptive B. coli) and the effluent was inferior in this respect to that prior to pre-chlorination. The observations and statements of J. W. Ellms, Filtration Engineer, Cleveland, O., in respect to pre-chlorination exerting a harmful effect on filter efficiency in the early stages is further confirmed by the Hopewell results. Once this unloading had run its course, however, the effluent remained low in gas-forming organisms.

Attention is called to the record of chlorine consumption which averaged 0.71 p.p.m. during the two years preceding pre-chlorination, whereas the four year average during pre-chlorination was 0.94 p.p.m. which covered the pre and post-chlorine consumption, i. e., an increase of 25 per cent in the total chlorine used. It is understood that residual chlorine is maintained at approximately 0.2 p.p.m. in the final effluent which seems from other experiences to be greater than is necessary for a pre-chlorinated effluent. Apparently then the 25 per cent increase is subject to some reduction without jeopardy to the "factor of safety" which post-chlorination rightly assumes when pre-chlorination also is practiced.

Niagara Falls, New York: (Niagara River Water).[b]—Plant No. 1 at Niagara Falls has its intake well out in the river toward the Canadian side and the plant does not suffer the pollution load that exists along the American shore where the intake of Plant No. 2 is located. The latter plant must handle a water highly polluted by Buffalo sewage and the quality is subject to wide variations as a result.

Pre-chlorination of the raw water is practiced under the supervision of B. T. Dignan, Superintendent of Filtration at Plant No. 2, primarily to relieve the filters of the bacterial load and pollution fluctuations and to reduce the dependence on single chlorination of the filtered water.

The pre-chlorination dosage applied during a characteristic month varied between 0.23 and 0.45 parts per million with a general average approximately 0.3 parts. This is insufficient to produce a filter effluent which will meet the Treasury Department Standard and post-chlorination is at all times essential. The final chlorination averages approximately 0.2 p.p.m. which, without pre-chlorination, would necessarily be greater to insure safety when dealing with such heavily polluted raw water.

Poughkeepsie, N. Y. (Hudson River Water).[b] — Pre-chlorination of the highly polluted raw water is practiced under the direction of T. F. Lawlor, Superintendent of Public Works, at Poughkeepsie. The water also receives double filtration. The primary filters are of the rapid and the final filters of the slow sand type. Post-chlorination is applied to the slow sand effluent. At this plant pre-chlorination and the double filtration make the final chlorination purely a safety factor.

The pre-chlorination dosage during 1927 varied between 0.56 and 0.70 p.p.m. and the post-chlorination dosage varied between 0.13 and 0.22 p.p.m. making a total average dosage of approximately 0.8 p.p.m.

The applied water at the primary filters has a median value of 10 B. coli per 100 c. c. and frequently lower. The primary filter effluent will not continuously meet the Treasury Department Standard, but the secondary filter effluent does so.

Rensselaer, N. Y.: (Hudson River Water).[b]—Under supervision of J. M. Caird, Consulting Chemist, Troy, N. Y., pre-chlorination of the raw water at the Rensselaer filter plant has been practiced for some time. At this plant the heavy pollution of the river necessitates heroic measures and a pre-chlorine dosage of between 1.4 and 1.9 p.p.m. has been applied during 1927—

[b] Data from plants reports analyzed and assembled by C. R. Cox[8], Asst. Engr., New York State Department of Health.

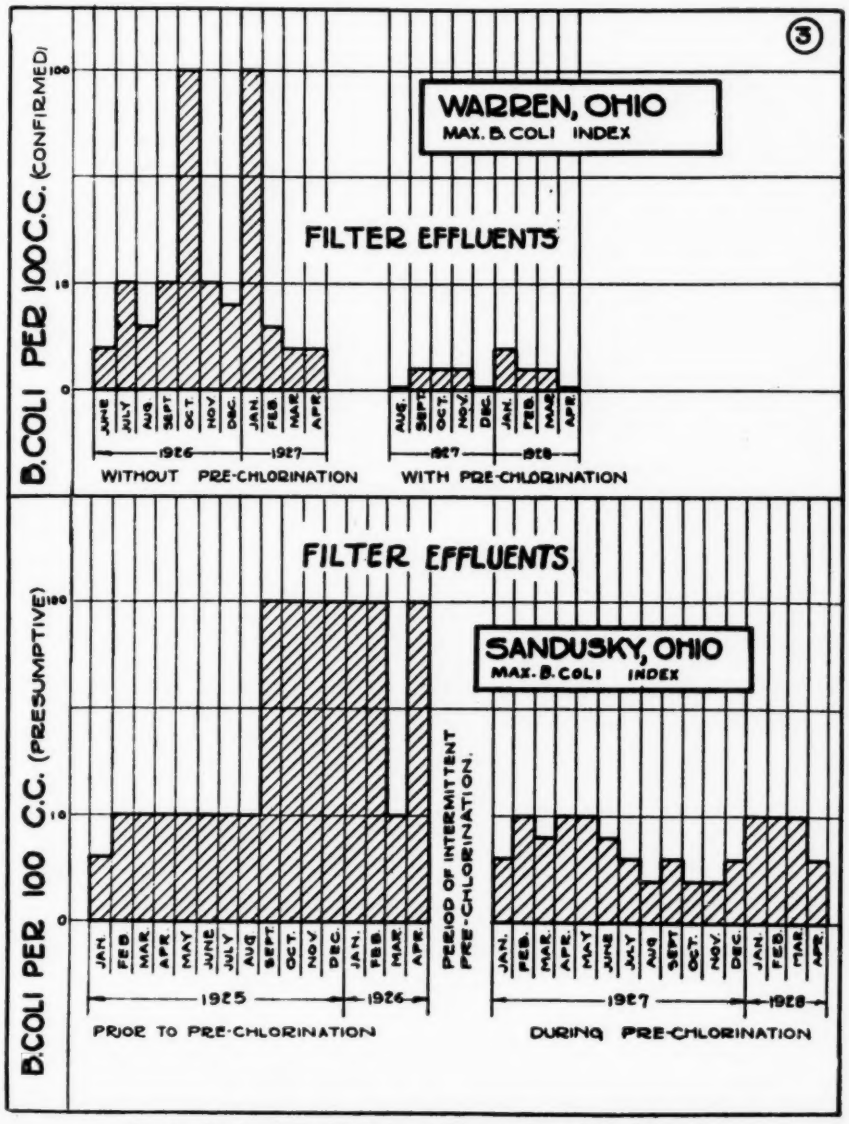


Fig. 3.—Maximum B. Coli Index at Warren, O., and Sandusky, O.

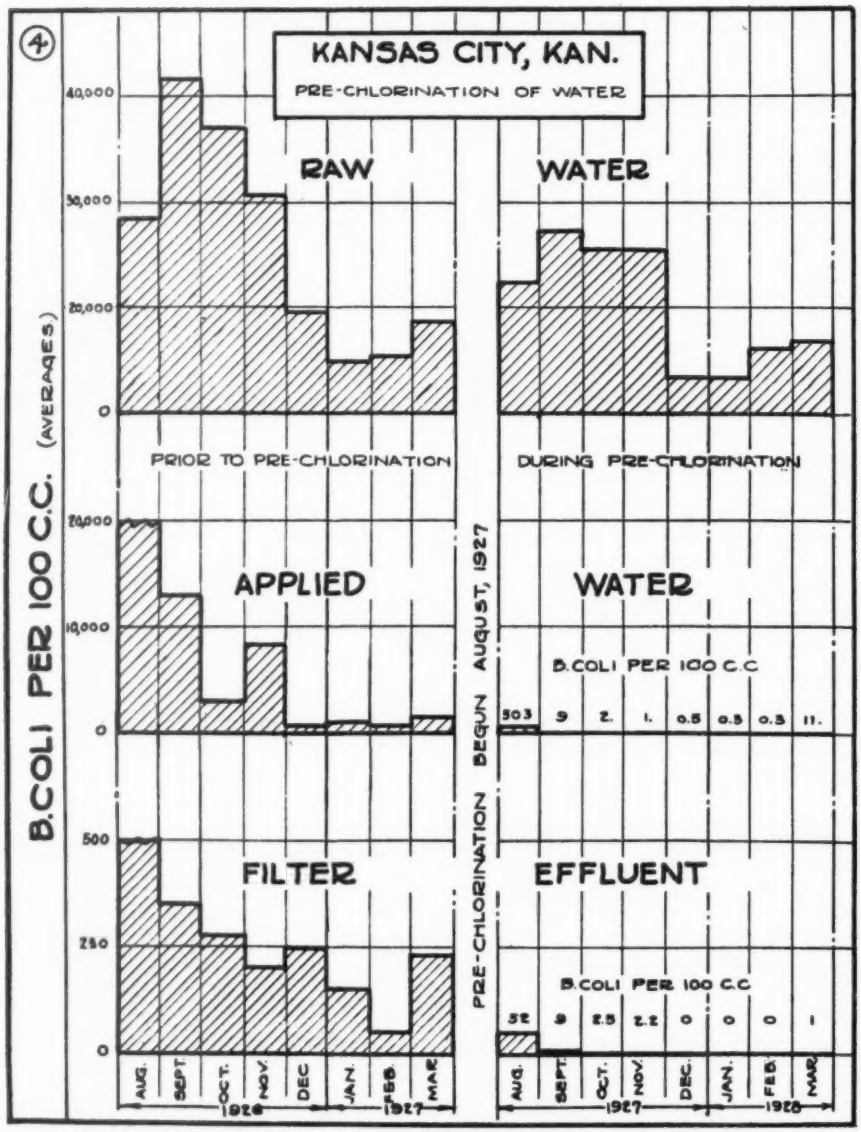

KANSAS CITY, KAN.
PRE-CHLORINATION OF WATER
RAW WATER
PRIOR TO PRE-CHLORINATION
DURING PRE-CHLORINATION
APPLIED WATER
FILTER EFFLUENT
B.COLI PER 100 C.C. (AVERAGES)
PRE-CHLORINATION BEGUN AUGUST, 1927
B.COLI PER 100 C.C
503 9 2. 1. 0.5 0.5 0.5 11.
B.COLI PER 100 C.C
52 9 2.5 2.2 0 0 0 1
AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR.
1926 1927 1927 1928

Fig. 4.—Chart Showing Effectiveness of Pre-Chlorination at Kansas City, Kan.

the average being about 1.5 p.p.m. To the effluent is applied between 0.4 and 0.6 p.p.m. to maintain a residual of 0.2 p.p.m. The residual chlorine in the applied water is maintained at approximately 0.5 p.p.m. It is reported that the heavy residual chlorine carried on the filters apparently keeps the beds in an easily washable condition and free of slime and mud accumulations and bed growths. Post-chlorination does not seem to be essential but is continued as a factor of safety because of the considerable dependence on chlorination to produce a safe water at the Rensselaer plant.

Rochester, N. Y.: (Lake Ontario Water).[b]—At the filtration plant of the Rochester and Lake Ontario Water Company, J. F. Amos, Chemist, practices pre-chlorination of the raw water and secondary chlorination of the applied water ahead of pressure filters. The operation is under the supervision of J. M. Caird, Cons. Chemist of Troy.

The raw water is subject to a variable intensity of pollution and organic content which prior to pre-chlorination made it difficult to insure effective sterilization by single chlorine application. At present the major sterilization is secured through pre-chlorination and a minor secondary dosage renders the maintenance of residual chlorine in the final effluent relatively simple. But slight residual is thus required and in connection with the lake water or normally low organic content the low residual chlorine maintained makes the water less liable to chlorinous tastes and odors .

During the period March, 1927-February, 1928, the pre-chlorine dosage varied between 0.20 and 0.67 p.p.m. and the secondary application to the applied water varied between 0.03 and 0.13 p.p.m. The median figure for the total chlorine applied was approximately 0.32 p.p.m.

Raleigh, N. C.:—J. S. Whitener, formerly Superintendent of Filtration at Raleigh, N. C., and now Assistant Engineer of the North Carolina State Department of Health, reports further progress in pre-chlorination at the Raleigh filter plant

Mr. Whitener[2] read a paper at the 1927 meeting of the North Carolina Section of the American Water Works Association which gave an account of the results following chlorine application to the applied water ahead of the filters. An earlier experiment with pre-chlorination of the raw water had not shown any marked improvement in conditions whereas the application to the coagulated and settled water gave a very apparent improvement in the condition of the filter beds and eliminated the "murkiness" previously possessed by the filter effluent. Simultaneously the bacterial quality was improved, and the wash water was reduced. Mr. Whitener now reports further data and continued success. The comparison of the average length of filter runs prior to pre-chlorination (1927) and the same months during pre-chlorination (1928) follows:

Raleigh, N. C.
Average hours filter runs

Month	Prior to Pre-chlorination 1927	During Pre-chlorination 1928	% Increase
January	24	37.5	56.2
February	24	43.6	81.6
March	29	42.5	46.5
April	24	42.4	76.7

The filter beds continue to remain in the improved condition secured following introduction of pre-chlorination. The wash water has been reduced more than 50 per cent. The filter effluent shows no B. coli and the total bacteria average less than 0.5 per c.c. The water in the clear water basin continues to remain clear and sparkling at all times which was not the condition prior to pre-chlorination.

The pre-chlorine dosage over the period January-April, 1928, has averaged 0.32 p.p.m. and post-chlorine dosage 0.16 p.p.m. making the total consumption 0.48 p.p.m. whereas with final chlorination only during the same period in 1927, it averaged 0.36 p.p.m., an increase of but 0.12 p.p.m. Residual chlorine of approximately 0.2 p.p.m. is carried on the filters but this completely disappears during passage through the sand bed and no residual is found in the effluent.

Southern Pines and Fayetteville, N. C.—Mr. Whitener reports that the recent experimental pre-chlorination of the raw organically stained waters at the filtration plants at Southern Pines and Fayetteville indicates that superior coagulation and greater color removal have been secured during pre-chlorination. Simultaneously the filter runs have increased. The State Department of Health has recommended that pre-chlorination be adopted at both plants.

Toronto, Ont. (Lake Ontario Water.)—N. J. Howard, Bacteriologist in Charge, Toronto Filtration Plant, reports that during super-chlorination when pre-chlorination is discontinued

the rapid sand filter effluent becomes slightly turbid and the amorphous matter and bacterial content of the effluent increase preceptibly. In Howard's opinion "pre-chlorination of water, which is non-susceptible to taste production, is at all times beneficial in a physical as well as bacteriological sense."

Chester, Pa. (Delaware River Water.)—Lyle L. Jenne, Chemical Engineer, Chester, Pa., in charge of the Chester filtration plant, reports that pre-chlorination of the raw water was initially practiced to secure elimination of foreign tastes and odors which previously appeared intermittently in the filtered water. The raw water was tested daily to ascertain whether pre-chlorination would improve the taste or odor and the process applied during such periods as the tests indicated it to be of advantage. During the past three years this intermittent practice has been successfully employed. Recently the chlorination capacity has been increased and now continuous pre-chlorination is also employed to reduce the bacterial load on the filters. Publication of data is not warranted because of the limited period during which continuous pre-chlorination has been in use at the Chester plant.

Philadelphia, Pa. (Schuylkill River Water.)—Lyle L. Jenne, Chemical Engr. of the Bureau of Water, Philadelphia, Pa., in charge of the water purification plant, began pre-chlorination of the raw water at the Queens Lane rapid sand filter plant in November, 1927, primarily for the purpose of reducing the bacterial load on the filters. How well this has been accomplished is shown by the following data[c]).

Philadelphia, Pa.
Queen Lane Rapid Sand Filters
(B. coli per 100 c.c. in Applied Water)

	1927 No Pre-chlorination	1928 Pre-chlorination	% Reduction
January	1540	19	98.5
February	1640	410	76.0
March	2250	10	99.5
April	2230	10	99.5
November*	850		
December	16		

*Pre-chlorination begun Nov. 6, 1927.

Baltimore, Md. (Gunpowder River Impounded Water).—James W. Armstrong, Filtration Engineer, Bureau of Water Supply, Baltimore, Md., has forwarded a brief statement concerning pre-chlorination of the raw water at the Montebello Filters during the summer of 1927.

During 1926 the raw water contained biological growths and algae to an extent that caused serious shortening of filter runs and necessitated frequent "jolting" of the filter beds with wash water. Finally it became necessary to wash all of the sand in the filters with Nichols machines.

Beginning May, 1927, pre-chlorination was introduced and Mr. Armstrong has supplied a statement to the effect that "no difficulty with the filters was experienced and the Montebello Filters were able during 1927 to keep up to the increased summer demands without difficulty. The general opinion points to a real advantage from pre-chlorination which will further be substantiated or disproved during continuous pre-chlorination throughout the present (1928) summer." Data from the 1927 operations are therefore withheld.

(c) Courtesy Lyle L. Jenne, Chemical Engineer, Chester, Pa.

Super- and De-Chlorination at Toronto

Norman J. Howard*

Super-chlorination of the City of Toronto water followed by de-chlorination with sulphur dioxide, for taste prevention, was inaugurated in the fall of 1926 and continued for a period of three months. In March, 1927, because of recurrent tastes, instructions were received to resume treatment as soon as possible. In June, 1927, five new machines were added to existing equipment. The available apparatus at this time consisted of eleven Wallace & Tiernan machines of 300 lb. capacity, seven machines being used for chlorination and four for applying sulphur dioxide for de-chlorination. This equipment has since been increased and at the present time consists of fourteen machines, each machine having a 300-lb. capacity per 24 hours. Provision is to be made in the near future for the use of one ton chlorine containers thereby reducing the cost of chlorination to approximately one-half the figures reported herein.

Laboratory experiments previously published[3] showed that taste in Lake Ontario water, caused by the formation of substitution compounds of phenolic and unknown origin occurring in the presence of chlorine, could be prevented by the application of large doses of chlorine. The amount of this reagent was computed at 1.2 parts per million. As the water became colder in the winter months the chlorine had to be increased 2.0 parts. In actual operation covering a continuous period of eleven months from June, 1927, to May, 1928,

*Bacteriologist in Charge, Toronto Filtration Plants, Center Island, Toronto.

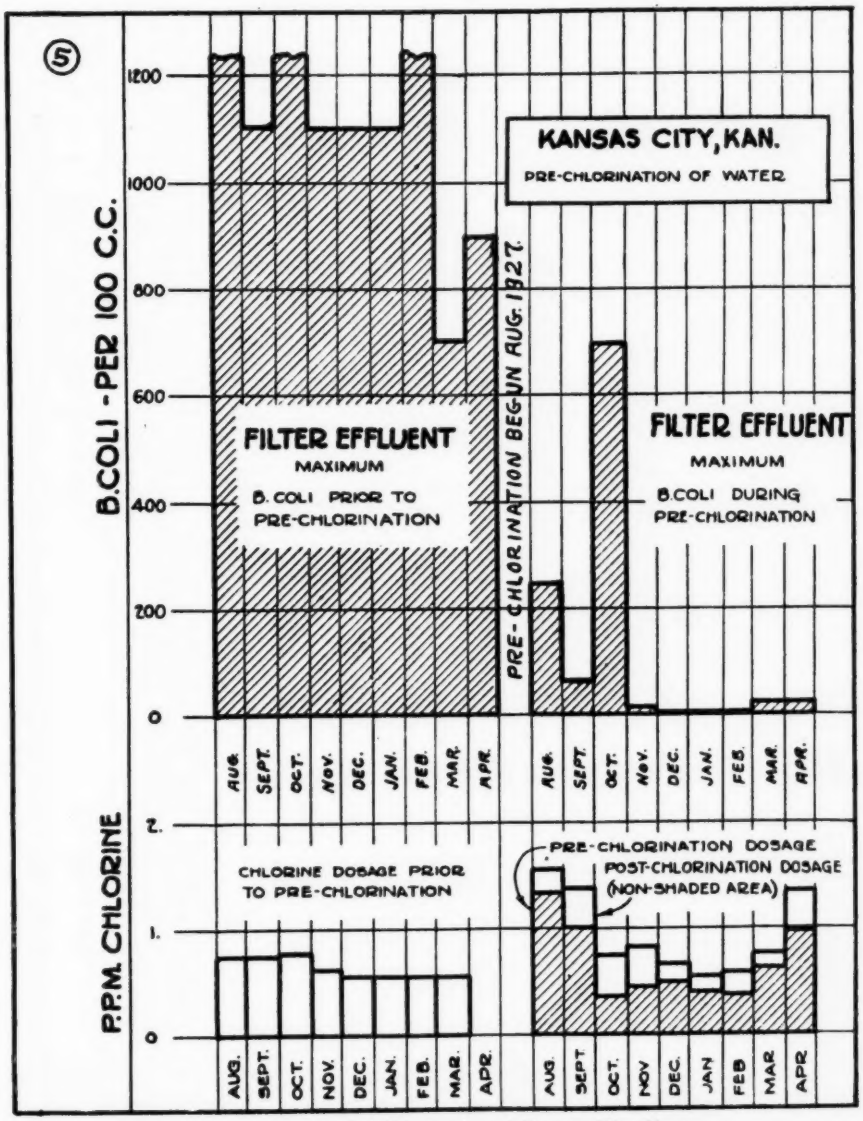


Fig. 5.—Effect of Pre-Chlorination at Kansas City, Kan.

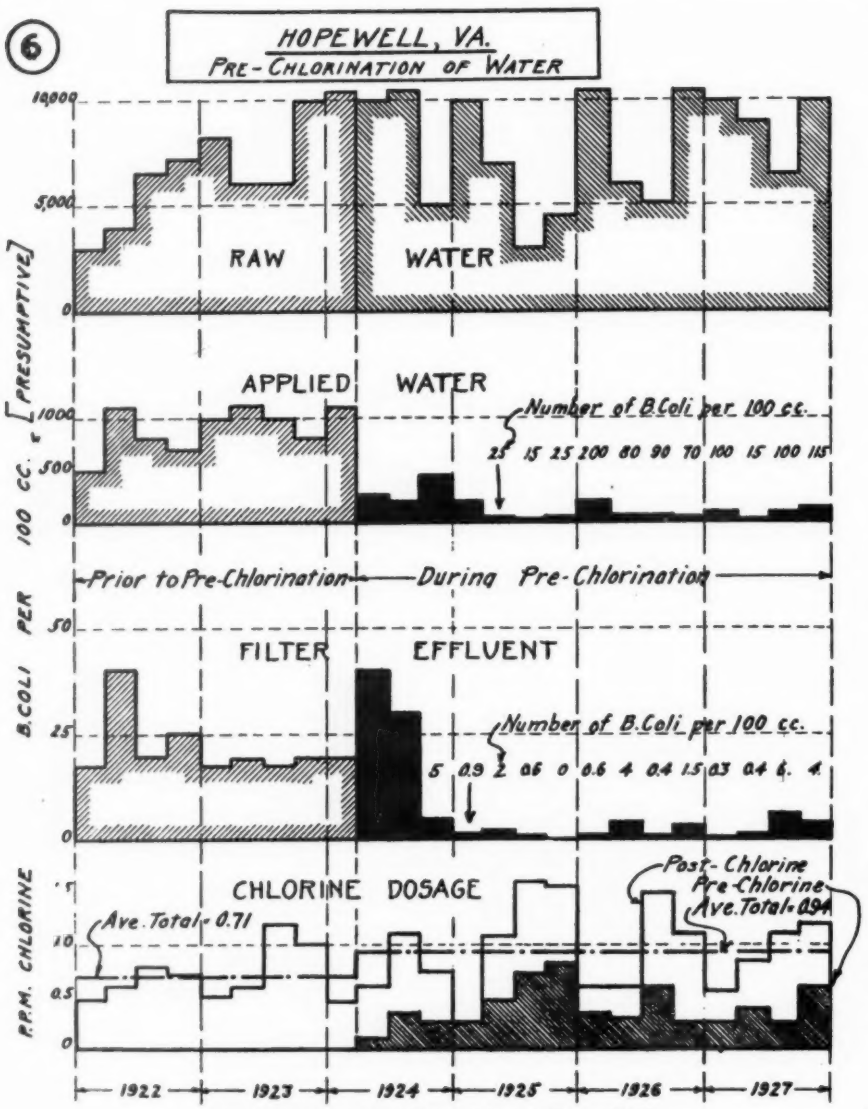


Fig. 6.—Effect of Pre-Chlorination at Hopewell, Va.

the chlorine dosage has occasionally been increased up to 2.5 parts per million.

The treatment of the water for taste prevention is intermittent and is dependent upon the prevailing wind direction. Frequent laboratory tests are made during day and night, the ammoniacal nitrogen test being the index of probable taste production. As the ammonia increases the chlorine dose is raised until the maximum dose is reached. As soon as the laboratory figures show a reduction to normal conditions as judged by chemical tests the chlorine is cut down to the usual dose. The de-chlorinating dose is regulated by ortho-tolidin tests made on the water as it enters the distribution system.

During a 334 day period the treatment was used on whole or in part of 167 days. Not a single taste complaint was filed during the period of super-chlorination. On one occasion, due to faulty operation, the chlorine dose was not increased according to instructions and a distinct taste occurred in the downtown area. Within one hour after increasing the chlorine dosage the water was free from taste.

The importance of complete removal of the residual chlorine, particularly in water susceptible to taste production cannot be overemphasized. Our experience has shown, that taste will only occur in a water which normally would have developed taste following the application of a small dose of chlorine. In other words, non-susceptible water which might be super-chlorinated will not give a post-treatment taste if a slight excess of chlorine is left in the water. From a safety point of view residual chlorine is not needed in water which has been super-chlorinated.

The plans for the new one hundred million gallon mechanical plant for Toronto make full provision for super- and de-chlorination treatment and include provisions for the use of one ton chlorine containers and evaporators. This section of the plant when installed will be the most complete and modern in North America.

Recent experimental work carried out by Frank Hannan in the Filtration Laboratory may result in placing a new light on the real cause of taste in chlorinated water. Combined studies are at present being carried out by Frank Hannan in Toronto and John R. Baylis in Chicago, and it is hoped that the detailed results of their work will shortly be available for publication.

Table I below shows the chlorine and sulphur dioxide dosages. Table II shows operation and chemical costs.

Summary.—The average amount of water treated daily from June 13, 1927, to May 13, 1928, was 74.78 million Imperial gallons.

The maximum dose of chlorine applied during the super-chlorination period was 2.5 parts per million and the minimum 0.8 parts.

The maximum and minimum dose of sulphur dioxide was 2.0 parts and 0.8 parts per million, respectively.

The treatment was completely successful and a tasteless water was furnished to the consumers.

Super-chlorination provides a very high factor of safety.

The additional cost incurred by super-chlorination was approximately $0.78 per million Imperial gallons—$0.96 per million being the cost during ordinary chlorination.

The combined cost for sterilization and taste prevention treatment involved in maintenance and operation was $43,360.37, equivalent to $1.74 per million Imperial gallons which is subject to material reduction through purchase of chlorine in 1-ton containers.

Ammonia or Permanganate in Conjunction with Single or Double Chlorination

Very probably there are instances in which ammonia, ammonia salts or permanganate treatment in conjunction with chlorination, for the purpose of taste prevention, have been applied which have not come to the attention of the author. The limited number of installations wherefrom data has been supplied will be reviewed without intent to ignore other cases.

London, England.—Sir Alexander Houston, Director of Laboratories, Metropolitan Water Board, London, England, has supplied the author with statements given below.

The following taste prevention measures are compared. (Note: The statements in quotation marks are actually those of Sir Alexander Houston taken from a recent communication to the author.)

1. Pre-ammoniation.
2. Chloramines.
3. Permanganate.
4. Super- and de-chlorination.

"The conditions under which chlorination has to be applied vary so greatly that it is not possible to lay down any hard and fast rule as to which of the above expedients is the best."

Table I—Showing Maximum, Minimum and Average Dose of Chlorine, Together With Maximum and Average Amounts of Sulphur Dioxide. Parts Per Million

	Chlorine						Sulphur Dioxide	
	Slow sand plant			Drifting sand plant			De-chlorinating plant	
Month	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Aver.
June '27	1.2	1.0	0.60	1.8	1.0	0.72	1.5	0.459
July	1.5	0.8	0.68	1.8	0.8	0.76	1.5	0.512
August	1.5	1.0	0.74	1.8	1.0	0.85	1.3	0.526
Sept.	1.5	1.0	0.82	1.8	1.0	0.96	1.4	0.634
Oct.	1.5	1.0	0.65	2.0	1.2	0.69	1.6	0.450
Nov.	1.8	1.0	0.65	2.5	1.2	0.73	1.4	0.441
Dec.	1.8	1.2	0.64	2.2	1.3	0.69	1.6	0.418
Jan. '28	1.8	1.5	0.514	2.2	1.5	0.58	1.6	0.336
Feb.	1.8	1.5	0.769	2.2	1.5	0.921	1.6	0.624
Mar.	2.2	1.5	0.975	2.4	1.5	1.17	1.8	0.832
April	2.2	1.5	0.941	2.4	1.5	1.05	2.0	0.745
May	1.5	1.5	1.8	1.5	1.5	0.447	1.2	0.315

NOTE: The average amount of chlorine applied when super-chlorination was not being practiced varied between 0.30 and 0.45 parts per million.

Table II.—Showing Maintenance and Operation Cost Figures, June, 1927-May, 1928

Chlorine, 94.95 tons	$13,231.57
Sulphur dioxide, 67.28 tons	13,519.60
Labor, 8 men	13,609.20
Maintenance and incidentals	3,000.00
Total	$43,360.37

Note: Cost of chlorine during this time was $139.50 per ton. Price of liquid sulphur dioxide in 1927 was $225 and in 1928, $162.33 per ton. Cost of chlorine in 1928 is $149.50, but the use of one ton containers will reduce the figure by approximately half. The "averages" above are not representative of the chlorine used for super-chlorination. The maximum and minimum figures are representative of the variations during super-chlorination only.

1. "In the case of pre-ammoniation, it is essential that the ammonia or ammonia salt be added to the water and thoroughly mixed with it before the chlorine is applied."

2. "The use of chloramines has the advantage of requiring but one point of application, but has the disadvantage that much of the chlorine required is lost in the reaction with the ammonia and the yield of chloramine does not seem to be quantitative. Di-chloramine appears to prevent the formation of tastes and sterilizes as well or slightly better than an equal dosage of chlorine."

"The Hampton (Kew Works) experiments go to prove that a simple chloramine process, i.e., mixing chlorine solution and ammonium chloride in solution in molecular proportions is practicable. In dilute solutions similar to those used in simple chlorination at least 75 per cent yield of chloramine is to be expected."

3. "Permanganate has the advantage of being capable of being applied either before, after, or simultaneously with the chlorine. A few experiments indicate relatively large dosages are required, but generally speaking it has proved effective in dosages of 0.24 to 0.96 p.p.m. It has the disadvantage of imparting color to the water, and therefore cannot be used successfully with waters of high organic purity."

4. "Super and de-chlorination is perhaps the most definite in preventing tastes and for rapid and effective sterilization. The process is perhaps best applicable to waters of high organic purity."

For details concerning the Metropolitan Water Board large scale practices with pre-ammoniation and permanganate treatment the reader is referred to the 20th and 21st Annual Reports of this Board[4].

In treating the Kew River water, during the winter months only, the supply receives pre-ammoniation continuously and permanganate of potash in addition whenever there is a probability that tastes may develop. Ammonia salts are applied at a point approximately 1 mile ahead of the chlorination and at a rate to provide 0.25 p.p.m. (NH_3) content. Occasionally permanganate is also applied at the chlorination station at a rate of 0.2 p.p.m. $KMnO_4$. Chlorine is applied at an average rate of 0.33 p.p.m. The treatment has met with complete success at a total chemical cost of 41c per million gallons.

At Hampton (Thames River) when the chlorine dosage was constant at 0.33 p.p.m., and ammonia was applied intermittently at a rate of 0.25 p.p.m. (NH_3), the results on the ammonia days showed that only one-half the number of samples contained B. coli in 100 c.c. portions compared with the number of 100 c.c. portions showing B. coli on days of chlorination without pre-ammoniation. The contact period available prior to sampling, however, was six hours, which period is essential to secure the full effect when ammonia is applied, unless the chlorine dosage can be increased.

Sir Alexander Houston in his various reports shows that use of chloramine, or pre-ammoniation, with chlorination reuqires a period of 4 hours if the most economical dosage of chlorine is to be effective. The contact period may be materially shortened by increasing the chlorine dosage.

In large scale experiments on the Thames water at the Kew Works the di-chloramine process of Harrold, (i.e., mixing chlorine water and ammonia solution or solution of ammonia salts in the ratio of 8 chlorine to 1.2 parts NH_3 prior to introduction into the water) was applied. On alternate days chlorine alone was applied and the results compared. With equal chlorine dosages after six hours contact the results were the same for chlorine as for di-chloramine but after 32 hours the chloramine results were superior.

If, as seems to be shown by the Metropolitan Water Board, large scale experiments, the di-chloramine process effectively sterilizes and prevents taste production, this process will be more attractive than pre-ammoniation from a cost standpoint.

The costly element is the ammonia and therefore the ratio of 1.2 NH_3 to 8 chlorine to produce di-chloramine is more attractive than the use of more ammonia in pre-ammoniation followed by less chlorine. For example:

Ammonia (NH_3) at 15c per lb.
Chlorine (Cl_2) at 8c per lb.

a.	Dichloramine ($1.2\ NH_3$:8Cl) chlorine 0.5 p.p.m.	0.5 p.p.m. chlorine 0.07 p.p.m. ammonia cost per million gallons—42c
b.	Pre-ammoniation (chlorine 0.33 p.p.m.)	0.33 p.p.m. chlorine 0.25 p.p.m. ammonia cost per million gallons—53c
c.	Pre-ammoniation (chlorine 0.5 p.p.m.)	0.5 p.p.m. chlorine 0.25 p.p.m. ammonia cost per million gallons—65c

Greeneville, Tenn. (Softening Plant.)—Advice from J. W. McAmis, Superintendent of Water Commission, at Greeneville, Tenn., is to the effect that pre-ammoniation of the raw water at the rate of 0.25 p.p.m. ammonia and chlorination of the filter effluent continues to prevent taste development in the distribution system. The original report by McAmis[5] and a subsequent paper by the author[6] contain detailed information concerning the process.

Permanganate-Chlorine Applications

Rochester, N. Y. (Lake Ontario Water.)[b]—Under the supervision of J. M. Caird, Cons. Engr., permanganate treatment of the raw water at the plant of the Rochester and Lake Ontario Water Co. was begun in January, 1927, as a taste prevention measure. Apparently this is the first instance in America where the permanganate has been continuously applied. After more than a year of operation the permanganate treatment seems to be entirely effective in conjunction with pre-chlorination followed by secondary chlorination.

The permanganate is applied to the raw water almost simultaneously with the pre-chlorine application. The application is controlled by carefully watching changes in chlorine demand of the raw water. Increased demand indicates increasing organic content of the water which in turn indicates that polluted waters of the Genesee River are reaching the intake. This is a signal to begin permanganate treatment and to boost the pre-chlorine dosage to secure desired results. Change of winds which drives polluted water away from the vicinity of the intake allows for discontinuance of permanganate treatment, but a careful watch is always maintained to detect approach of the taste producing waters.

The following table indicates the periods of permanganate application and the rates applied:

Rochester, N. Y.
(Permanganate Treatment and Double Chlorination)

1927 Month	p.p.m. $KMnO_4$ median	maximum	Remarks
March	0.08	0.08	applied 12 days
April	0.06	0.09	15
October*	0.07	0.12	16
November	0.04	0.04	1
December	0.09	0.13	15
Jan., '28	0.05	0.14	11
February	0.05	0.13	17

*None applied between April and October.

Permanganate of potash in commercial grade costs from 18 ct. to 20 ct. per pound and may be fed from dry feed machines or solution tanks. The maximum cost for permanganate treatment at Rochester is 23 ct. per million gals. and the median cost has not exceeded 15 ct. per million gals.

Buffalo, N. Y. (Western New York Water Co.—Lake Erie Water.)[b]—The raw water is fouled by coke plant wastes which intermittently reach the intake. The only measure of purification is single chlorination which must necessarily be maintained at a relatively high rate.

Mr. H. F. Buy of the Western New York Water Co., a pioneer in chlorination of water, started permanganate application on January 16, 1928. The initial rate was but 0.03 p.p.m. which was thereafter varied to suit conditions as indicated in the tabulated data following:

Western New York Water Co.—Buffalo, New York
(Permanganate Treatment)

1928	p.p.m. $KMnO_4$ Min.	Max.	Aver.	p.p.m. Chlorine Min.	Max.	p.p.m. residual chlorine
January	.03	.03	.03	.23	1.40	0.2 plus or minus
February	.03	.03	.03	.25	0.34	0.2 plus or minus
March	0.02	.48	.03	.19	2.10	0.2 plus or minus
April	.03	.08	.04	.29	0.50	0.2 plus or minus

In March serious pollution reached the intake as is evidenced by the high chlorine demand and permanganate required. Nevertheless it was possible to effectively sterilize the water without taste production. Apparently no complaints have been received relative to permanganate stains in the water. The particular interest here lies in the fact that chlorination has been called on to function alone where a filtration plant for some time has been considered desirable and is at this writing under construction. The results of the past season have shown what can be accomplished in chlorination of an unfiltered polluted water as a temporary expedient until more adequate purification measures can be secured.

Rensselaer, N. Y. (Hudson River Water).[b]—Experiments at the Rensselaer filtration plant during the past winter indicated permanganate application to the raw water effectively prevented taste production, and it will be again experimentally applied should phenol wastes become troublesome.

Chlorine in Algae Control

Chlorine will probably not entirely supplant copper sulphate as an algaecide, but it is becoming increasingly evident that it has a place in the field of algae elimination and has peculiar advantages in some instances that render it more desirable than copper sulphate. One for instance, is the accuracy of application to a flow of water past a given point, and another is the additional advantage which chlorination simultaneously possesses, i. e., sterilization and oxidation. The cost of chlorine is considerably less than that of copper sulphate and there is no reason for controversy in case some of the chlorine remains in the treated water.

The experiences of L. B. Mangun, Superintendent of Filtration, Kansas City, Kans., in the matter of algae control in a distribution reservoir wherein chlorination was employed in a novel manner will be thoroughly covered in a paper on the subject to be read at this meeting, therefore the reader is referred to Mr. Mangun's paper for the details and results secured.

New York City, N. Y.—Dr. Frank E. Hale, Director of Laboratories, Department of Water Supply, New York City, and also in charge of chemical treatment of the various water supplies of the city, has placed at the disposal of the author the following data on chlorine as an algaecide.

Chlorine dosage of 0.3 p.p.m. applied to the New York water supply attacks microscopic organisms and sets free the distasteful oils from several varieties of algae. Additional chlorine applied destroys the taste thus produced.

A dosage of 0.5 to 0.7 p.p.m. has destroyed and rendered tasteless 100 units of synura and above 0.7 p.p.m. 200 units can be handled. A growth of uroglena (2000 units) has been killed and taste destroyed with 0.5 p.p.m. chlorine, and dinobryon (500 units) has been destroyed and deodorized by 0.5 p.p.m. chlorine. The same dosage given a water entering a storage reservoir caused a 25 per cent reduction of organisms during storage whereas previously there had been a considerable increase. The organisms suffering reduction included asterionella, anabaena, aphanizomenon, coelosphaerium, tabellaria, melosira, volvox, and ceratium.

During the year 1927, chlorination of the New York Water Supply has controlled organisms and tastes as follows:

Synura . . (¾ units) dosage 0.3 p.p.m., residual 0.05 p.p.m.

Asterionella (1350 units) dosage 0.7 p.p.m., residual 0.2 p.p.m.

Synura . . (Croton supply) dosage 0.55 p.p.m., residual 0.1 p.p.m.

Synura (Long Island Ponds) dosage 0.3-0.5 p.p.m., residual 0.1 p.p.m.

In the well water supply of the Jamaica Water Co. crenothrix caused complaints. It was effectively killed in the system by a dosage of 0.5 p.p.m. (residual 0.1 to 0.3 p.p.m.) and blown off at the hydrants. It is sometimes the case that organisms are killed and taste increased as a result of small chlorine dosages, but for some reason the taste and odor dissipate during the passage of the water through the aqueduct and reservoirs.

Mexia, Texas. (Limestone Springs and Deep Wells.)—At Mexia, Texas, R. D. Morgan, Superintendent of Water Works, employs continuous chlorination almost solely as a means of algae growth prevention in service reservoirs. After various experimental applications Mr. Morgan advises that for best results the following procedure seems to be the most effective. Chlorine (about 0.72 p.p.m.) must be applied to the incoming water not less than 20 ft. ahead of a baffled mixing chamber constructed at the reservoir. At the mixing chamber inlet roughly 1.12 grains per gallon of hydrated lime are added. The effluent which enters the reservoir along one side near the surface creates currents which produce a very fair distribution of the incoming water containing 0.3 to 0.5 p.p.m. residual chlorine. Copper sulphate is occasionally applied to dead spots in the corners of the reservoir.

Prior to chlorination the Mexia reservoir was subject to rapid increases in algae growth after each cleaning and, in addition to the use of copper sulphate, in hot weather, weekly cleanings were necessary. After each copper treatment the water was filled with dead and decomposing algae which resulted in considerable complaint and damage at bottling works, laundries, etc.

Chlorination has been in use for almost two years and in a recent letter Mr. Morgan makes the following interesting statement: "We have had no trouble since starting chlorination and have not had to clean the reservoir for eighteen months." Thus it appears that the treatment which has stood the test of a part of one summer and an additional entire summer may be considered a preventive rather than a cure.

The author saw the conditions existing at Mexia prior to chlorination and the algae so abundant (protococcus) was apparently a copper resistant species. Oscillaria was also abundant.

That chlorination effectively prevents the quantity and quality of growth formerly present in the Mexia reservoir is, to the writer's mind, a remarkable fact; but some credit is due the lime, for without it the efficacy of the chlorine, as reported by Mr. Morgan, was apparently not so great.

Chester Cohen, District Engineer, Texas State Department of Health, reports that in addition to Mexia the following towns in Texas are successfully using chlorine for algae control: Graham, Donna, Grand Saline, and Laredo.

At Richmond, Virginia, and Red Bank, New Jersey, chlorination pre-

verts growth of algae in the aeration and clear water basins.

Retardation or Prevention of Sludge Putrefaction in Coagulation Basins

Sludge deposits in coagulation basins at plants treating organic waters are subject to anaerobic decomposition. In summer and particularly so in southern climates gas production within the sludge deposits results in rising sludge which is sometimes referred to as "basin turnover." In Panama the basins at the Gatun plant, during the writer's service there, had to be thoroughly cleaned every fourteen days and at some seasons even more frequently, or else difficulties from sludge eructations occurred. These disturbances distribute ill-smelling and bad tasting decomposition products through the water.

At Elizabeth City, N. C., and Norfolk, Va., pre-chlorination has proven effective in improving the basin condition and in increasing the length of service between washings.

At Rusk, Cisco, and Henderson, Texas, where coagulation and clarification on the fill and draw plan in multiple tanks is practiced, chlorination of the coagulated influent during filling has proven effective in preventing rising sludge in the quiescent tanks.

Lake Dundee, N. J. (Passaic River Water.)—A filtration plant at the Lake Dundee plant of the National Silk Dyeing Co., was constructed in an attempt to purify the waters of the heavily polluted Passaic River which at times in summer resembles a septic tank in appearance. The plant effluent was intended for industrial use only. Trouble was experienced with putrefaction and liquefaction or gas lifting of sludge in the large coagulation basins. Upon the recommendation of Churchill Hungerford, Consulting Engineer, pre-chlorination was adopted to reduce putrefaction and frequency of basin cleaning. Sufficient chlorine is applied to the raw water to insure a slight residual in the basin effluent and from reports available the process is successful.

The author wishes to acknowledge with appreciation the cooperation, and assistance of the various persons mentioned in this paper.

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Acknowledgment.—The foregoing is abstract of a paper presented June 14 at the 48th convention of the American Water Works Association.

Profit in Sewage Sludge

Municipalities that are struggling with the problem of financing successful operations of their sewage treatment works may be both interested and encouraged by the experience of Schenectady, N. Y., which sold its entire output of sludge for 1927, for use as fertilizer by farmers and gardeners in the vicinity. According to the June 15 Ohio Health News reports available do not indicate the price received, but if it was anything commensurate with the fertilizer value of the sludge, as compared with stable manure or commercial fertilizers, the aggregate return must have been an appreciable factor in financing operation of the plant.

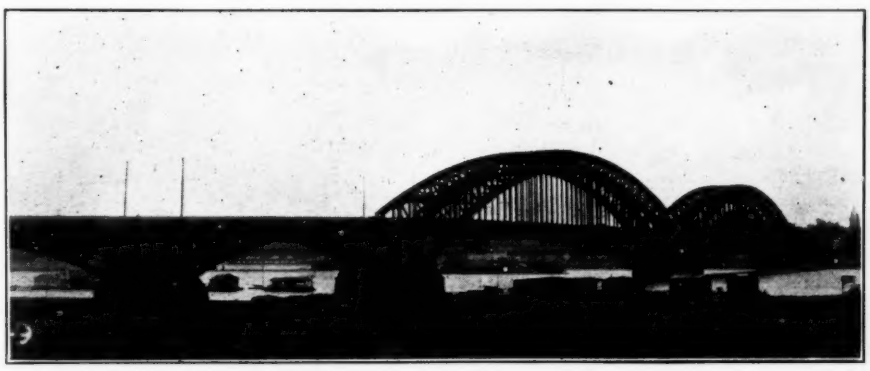
Many Ohio municipalities are taking advantage of the sewer rental law for financing effective operation of their sewage treatment plants, and New York is without the advantages provided by that pioneer statute; but it is to be remembered that successful operation of sewage treatment works also includes sludge disposal, for accumulation of sludge frequently constitutes a disposal problem difficult of solution. Successful marketing of the sludge, therefore, not only would enable the attainment of 100 per cent operation, but also would pay its own costs and constitute a material reinforcement to the financing of plant operation.

Marion is the only Ohio municipality that markets its sludge. Floyd G. Browne, chemist-in-charge, began its sale about a year ago, and sales have reached a steady increase at $4 a load, of about a cu. yd. At Canton, Charles C. Hommon, superintendent of plant, pumps the wet sludge to a large farm owned by the city, and the success attained there has caused a heavy demand from neighboring farmers for similar service.

This is the fourth consecutive year that all the sludge from the Schenectady plant has been sold as fertilizer. Initial steps in an intensive sales campaign were taken in 1924. The demand has grown each year, and scores of prospective buyers have been unable to obtain the fertilizer, while others could not obtain the amounts they desired. The increased demand is noteworthy in view of the fact that few sections of the country report any interest on the part of farmers in sewage sludge, which usually is a liability instead of an asset.

Necessarily, a marketing plan must be adopted if the sludge is to be sold, and the business-like marketing methods employed at Schenectady could well be copied by other municipalities. The plant superintendent has given a series of lectures each year before farmers' meetings, has repeatedly obtained the aid of the county Farm Bureau, and also has maintained a program of publicity through the local papers. Every effort has been made to show farmers how to use the sludge to best advantage. Schenectady parks have been using it, and reports indicate excellent results on grass and flower beds. Beginning this year, sludge has been delivered in test quantities to two golf courses, and scores of bags have been given free to local householders for lawns and gardens. This distribution of sludge among the citizens has created much interest in the treatment plant, and favorable comment has resulted from the visits of persons who never before knew that the sewage treatment plant existed.

Care has been taken to inform users of sludge to keep it away from all types of crops growing in or on the ground which go to the table without cooking.



Bridge at Dusseldorf, Germany. This Steel Structure Was Widened a Year Ago by Bracketing on the Outside to Accommodate Two Street Car Lines. This Doubling of Capacity Was Secured at a Very Nominal Cost as the Bridge Had Been Liberally Designed

Drainage and Traffic Protection Provisions for New Boulevard in Pasadena

By W. E. BARNEY
Assistant Engineer, City of Pasadena, Calif.

The city of Pasadena has recently completed the construction of Linda Vista Avenue, one of its main boulevards, through the Linda Vista residential district which is located along the west bank of a wide canyon known as the Arroyo Seco and at the foot of the San Rafael mountains. This gives an additional outlet for traffic to the fertile San Fernando Valley via Flintridge, Sunland and Tujunga.

A Rather Unusual View of Linda Vista Boulevard at Pasadena. Note the Extension Put to the 30-In. Culvert in Order That Drainage Might Be Carried a Safe Distance from the Base of the Wall

A Portion of the Boulevard. At This Point Motorists Are Protected by 12-In. Reinforced Concrete Curb and Chain Link Highway Guard

A large portion of the construction required the making of heavy cuts and fills and provision for cross drainage from the adjacent mountains. For the drainage Armco corrugated culverts were used. In crossing Cottonwood canyon a 300-ft. length of 30-in. diameter pipe was placed through a fill 50 ft. in depth. To obtain street drainage, reinforced concrete catchbasins with curb instakes and Armco corrugated pipe wells connected to the 30-in. pipe were used.

At the north end of the boulevard and near the Devil's Gate Flood Control Dam another Armco pipe was carried through a reinforced concrete retaining wall. This wall, which was 440 ft. in length and varied from 3 to 50 ft. in height, was constructed along the west bank of the precipitous Arroyo Seco, the channel of which is from 100 to 125 ft. below the elevation of the pavement.

This wall is shown in one of the accompanying illustrations. In design the wall consisted of the L-shape, cantilever, and counterforted types and along the top Page highway guard was installed. The fabric was fastened to steel posts by No. 6 gauge wire clamps, the posts being grouted into steel pipe sleeves set in the curb which was constructed as a part of the retaining wall. Ornamental knobs were placed in the top of each post; both posts and fabric being painted white except the knobs, which were painted black.

That it was necessary to adequately protect motorists at this point is evidenced by the fact that even at this early date the chain link guard and curb has been called into service by a speeding car over which a driver had lost control. Without the chain link guard this car would have plunged to the sloping bank 50 ft. below.

W. C. Earle is City Engineer and Superintendent of Streets, J. H. Allin is Deputy City Engineer, and the writer designed the work. J. E. Haddock of Pasadena was contractor.

Simplification for Fire Apparatus Capacity Approved

A general conference of manufacturers and users, hold June 27th, at the Department of Commerce under the auspices of the Division of Simplified Practice of the Bureau of Standards, approved a tentative simplification for fire engine pumping capacities.

The recommendation as approved, is as follows:

*300 gal. per minute at 120 lb. pressure.

*400 gal. per minute at 120 lb. pressure.

500 gal. per minute at 120 lb. pressure.

750 gal. per minute at 120 lb. pressure.

1,000 gal. per minute at 120 lb. pressure.

Capacities marked (*) or any other capacities less than 500 gal. per minute are not recognized as standard by the National Board of Fire Underwriters. In this connection the following resolution was passed by the conference: "The conference goes on record as indorsing the paragraph contained in the suggested specifications for gasoline automobile fire apparatus of the National Board of Fire Underwriters, dealing with the 300 or 400 gal. capacity." This paragraph reads:

"These machines are within the reach, financially, of villages and rural districts which otherwise could not buy equipment; they are more generally effective than the usual chemical engine in territories without waterworks systems, as some suction supply usually can be found. It must be recognized, however, that in some states little or no credit is allowed by the insurance rating organization for pumping capacity of less than 500 gal. a minute in one or two pumpers."

On account of the relatively small number of fire engines produced annually, as compared with other manufactured products in the mechanical line, there has been a natural tendency toward diversification, in an effort to exactly meet the requirements of users, according to manufacturers represented at the conference. Manufacturers and users have recognized the fact that unnecessary diversity of size or capacity results in increased cost and slower service, and makes it difficult to manufacture parts for stock.

Approximately six months ago, a number of manufacturers cooperated to secure figures in regard to existing diversity, and after several preliminary meetings, a committee of the manufacturers formulated the list of standard capacities which was approved at the general conference June 27th, as being sufficient to adequately cover all reasonable demand for stock fire engines.

This recommendation will become effective on Oct. 1, 1928, subject to annual review by the Standing Committee. This committee will consist of Charles H. Meigs, Commissioner of the Fire Equipment Institute; George S. Watson, Chief, District of Columbia Fire Department; Ross B. Davis, President of the International Association of Fire Chiefs; S. O. Cook, of the Boyer Fire Apparatus Co.; and D. C. Fenner, of the Mack International Truck Corporation.

The Division of Simplified Practice will shortly circularize the industry for signed acceptances to the approved recommendation. Before the recommendation can be published by the Department of Commerce, at least 80 per cent of the industry, by volume of annual production, must accept the same in writing.

Annual Dinner for Officials.—Detroit has an annual Officials' dinner for those holding city, county, state and federal posts. The dinner is given under the auspices of the Board of Commerce. Nearly 450 business and public officials attended the 1928 dinner.

Dead Ends in Water Mains

Effect on Capacity and Quality of Water

By S. B. MORRIS

Chief Engineer, Pasadena Water Department, Pasadena, Calif.

IN order to find out the policy of other water works and to learn what progress their executives had evolved for meeting the problem of dead ends, I wrote a note to eight of my friends in the water works fraternity. Their replies were unanimously opposed to the mainteance of dead ends wherever they could possibly be eliminated. Everyone provides a fire plug or blow off to bleed the dead ends of mains unless an active service can be placed at the extreme end of the main.

Practice of blowing off these bleeders varies. Some blow them off at fixed intervals of two weeks to two or more months; others bleed them only upon complaint or at irregular intervals as experience dictates. When dead ends are caused by valves being closed between pressures one large city makes a practice of cracking these valves sufficiently to cause some circulation from the higher to the low pressure.

Replies to my letter show that not all are agreed upon what the real source of difficulty is with the dead ends mains or the sealed services which present somewhat the same problem. Mostly the trouble appears to be with the taste and odor of the water due to products of bacterial action. One city engineer attributes this taste to the pipe or the pipe dip; another engineer believes the corrosion due to gasses formed is the greater problem.

In the short time allotted to me I shall attempt to briefly analyze and weigh the several problems pertaining to dead ends in water mains and sealed services.

Dead ends affect the carrying capacity of the mains for general and fire purposes. The stagnant water in dead ends causes tastes and odors and may affect the rate of corrosion of the pipes. Different metals used in the manufacture of the various kinds of pipe effect the water differently, and in turn the pipes themselves are affected differently by different qualities of water.

Effect on Capacity.—The undesirability of dead ends from the standpoint of main capacities for general and fire purposes is immediately evident. For the same sizes and lengths of pipe the dead end main will have not more than one-half the capacity of the circulating main and will be twice as subject to interruption or failure of service through being supplied from but one end. Water pressures will fluctuate more widely and water hammer is more severe in the dead end main. The circulating system tends to equalize pressures and drafts by spreading of the load factor.

Effect Upon Quality of Water.—In discussing the effect of dead ends upon the quality of the water served to the consumers, it is well to consider just what chemical and bacteriological reactions take place. The average city water contains more or less dissolved oxygen, organic matter, acidity or alkalinity.

The dissolved oxygen is rapidly consumed either by bacterial action or oxidation of the interior surface of the pipe. Aerabic types of bacteria must then die off entirely unless they are able to form spores which would continue only as spores. Anaerobic bacteria, however, will thrive and their numbers at any moment will be determined by the available organic food supply present.

The activities of aerobic bacteria are not productive of such especially bad odors and tastes as the anaerobic. It is to this latter class of organisms that we must attribute the worst dead end conditions. Normal laboratory procedure is effective only for aerobic types of bacteria and these at the body temperature of 37° C. Anaerobic bacteria grow better at 20° C.

When bacteria consume organic matter in the presence of oxygen the reduction products which they form are not objectionable and possess neither taste nor odor. When bacteria work upon the same types of organic matter in the absence of the all important dissolved oxygen the decomposition products which they form are foul smelling. Such products as hydrogen sulphide and other highly odoriferous sulphur compounds are formed.

While none of these products which give to stagnant water its characteristics odor are at all dangerous to the health, they are at times the source of such complaint by the consumers and a disturbing problem to the water superintendent.

Probably most true dead ends have little or no circulation though chemotaxis may play a part for we know that most bacteria will move toward available food. As the organic matter in the dead end becomes depleted, there may be some movement of the bacteria from the dead end toward the portion of the pipe where water is in motion and a fresh food supply is available. Such movement or circulation is not thought to be appreciable.

Tests made of active and sealed services from the end of the same 2-in. cast iron lateral show little or no apparent contamination of the active service.

What Tests Show.—I am much indebted to George Read, Superintendent of Meters and Services and to Carl Wilson, Director, Biological Laboratory for the Bureau of Water Works and Supply, Los Angeles, for many analyzes of water from scaled services and able discussion of the biochemical problem. The results of these tests and other analyses conducted in our own laboratories at Pasadena show widely varying conditions from which some general statements may be made.

In any given dead end bacterial action will increase rapidly until oxygen and organic matter are consumed after which the bacterial action will rapidly diminish to a very low condition. Foul gasses will begin with the failure of the oxygen supply soon reaching an optimum after which they will cease to be produced with the lessening bacterial action. Tests by Dr. Wilson indicate lesser bacterial action in sealed copper services than in sealed cast iron services, which may be due to germicidal action of the copper, though insufficient tests have been made to be conclusive.

Therefore we cannot expect any certain fixed time of flushing such, as every two weeks, every month or any other inflexible period to be proper for every water system, nor for every dead end in the same system. In fact, in almost every system the quantities of oxygen, carbon dioxide and of organic matter are so variable with the season and with the several sources of supply that only experience in the individual case can be used as a safe criterion. We are quite safe in saying that a very old dead end which has not been flushed will no longer require any flushing as bacterial action has practically ceased and the obnoxious gases are no longer produced.

Effect of Dead Ends Upon Corrosion.—There appears to be a general opinion that dead ends or sealed services are much more rapidly affected by interior corrosion than pipes through which water is constantly moving, A theoretical discussion of the active elements of corrosion, and observation of many sealed services in comparison with active services does not appear to sustain this opinion.

The most active corrosive elements in the average city water supply are: Dissolved oxygen, which we have seen is rapidly used up and does not re-

place itself; free carbon dioxide or carbonic acid, which may not in itself be used up, but which cannot continue to be active or effective without oxygen, and hydrogen-ion concentration. Hydrogen-ion concentrations represented by values of pH greater than 10 are only slowly corrosive, between pH 4.3 to 10 moderately, and less than pH of 4.3 rapidly corrosive. Here again oxygen must be present to break the polarizing film of neutral hydrogen stems on the metal to complete the corrosive action under the electro-chemical theory of corrosion.

We have not time here to go more fully into the detailed theories of corrosion and the effect upon the several metals now used for mains and service piping. Inspection of services in our Pasadena system varying from 10 to 41 years of age in both sealed and active condition appears to substantiate the fact that interior corrosion is not more rapid for the sealed service than for the active service and may be materially less, due to the absence of dissolved oxygen.

It would appear that frequent flushing of dead end mains may materially add to the rate of interior corrosion over that to be expected if the mains were not flushed. The optimum rate of dissolved oxygen and carbon dioxide for maximum corrosion may be brought about for a greater percentage of the time through such flushing than though the dead ends were allowed to reach their inactive condition through complete consumption of oxygen and other corrosive elements.

Effect of Electrolysis.—Dead end mains and services are naturally more subject to electrolytic action from stray street railway currents. If such dead end pipes or services are positive to the earth in the direction of their dead ends, currents will flow from them into the soil, thus concentrating corrosive action near the ends of such pipes.

From the above discussion we must conclude that dead ends are something we should restrict to an absolute minimum in any modern water works distributing system, for such dead ends tend to decrease pressures, lessen fire flows, increase shutdowns, increase water hammer, increase complaints of tastes and odors, in some cases they may increase corrosion, particularly from electrolysis. The growing use of duplicate mains on each side of a street should make the number of dead ends between pressure districts less necessary. In fact this is an additional argument for such duplicate mains.

The practice of locating fire plugs on dead ends as effective bleeders for the mains is desirable in flushing the pipe lines, but not so satisfactory from the standpoint of fire protection.

Cracking of valves between pressures to give a slow circulation from the higher pressures to lower ones is a hazardous procedure as far as the valve is concerned. A better procedure where such circulation is necessary, would be to install small by-pass valves for this purpose.

For average water conditions sealed services should present no greater problem than active services. Where severe conditions are known to exist, sealed services can be installed with the corporation cock at the main closed, and a valve box installed over such cock so that the service can be turned on when required. In this way water is not turned into the services until it is to become an active service. This is the present practice in some cities.

Acknowledgment.—The foregoing is from a paper presented at the 1928 Convention of the American Water Works Association.

Public Service as a Profession

The following interesting article pointing out the need for trained men in modern city administration is taken from the Toledo City Journal, a publication of the Commission of Publicity and Efficiency of Toledo, O.:

"To the victor belongs the spoils." This trite quotation, often attributed to Andrew Jackson, originated with Senator Marcy of New York. But the spoils system was flourishing in New York city over a decade before Jackson was elected president in 1828. It grew unchecked for over half a century, when, in 1883, the first national civil service law was passed. Since that time civil service has made considerable progress in cities, and today Indianapolis is the only city of over 250,000 inhabitants without civil service provisions. However, in many of these cities it is a dead letter.

Foundation of the Machine.—What is the theory underlying the spoils system? It is based upon the idea that all men are created equal and are equally able to fill public office. It is the foundation of the political organization and the "machine." Assuming all men of equal abilities, and conceiving all public offices and positions as political plums, it is but a step to the idea of rotation in office, giving little Jack Horners a chance to stick in their thumb and pull out a plum.

Is the spoils system inseparable from government? Is there any inherent reason why the public service should not offer a permanent career just as law, medicine, or business do? It may be said at the outset that the spoils system is purely American. It is unknown in England and German city administration. City councils come and go, but there administrative jobs are looked on as a trusteeship for the public, and not as a privilege of the office-holder. In Europe professional qualifications are considered the first requirement for the people in the administrative service. In American cities the first question usually is, "What did you do for the party?" And just so long as the American public demands nothing more of its public employes than it be loyal party supporters, it need not expect the efficiency of private business.

Complexity of the Job.—It may have been true that almost any man could fill any office capably in 1800, when keeping pigs off the public thoroughfares was one of the pressing problems of the community—when there were no sewers, no public street lighting, no public water supply, no crime problem, no traffic problem, and no street pavement except a few cobblestones. But the good old days are no more. Times have changed. Today the chief executive of the modern city is confronted with a varied array of problems that would stagger the head of the largest industrial concern in the country. From street railways to vice, and from water supply to playgrounds, from anonymous letters to job seekers, from municipal universities to street cleaning, the variety and complexity of the problems confronting the modern city executive is bewildering.

Trained Men Necessary.—There are few departments of city government that do not demand experts. Do American cities get and keep professionally trained administrators? The question answers itself. With the exception of a few departments, such as engineering and law, faithful party diligence is the main requirement of a public employe.

Why are there not more trained men in the service of the city? There are several reasons for this condition. In the first place, with a few exceptions, the best brains of the city are engaged in business and the professions. And why? Ask ten successful managers and professional men why they did not enter the public service and you will receive some such replies as these:

"The public service does not offer a career. A job depends on the political favor of the group in power. There is no assurance that the job will last more than two or four years if my political opinions do not tally with the electorate or the appointing authorities. There is no opportunity to transfer to a similar job in another city or state if I show superior ability. The attitude of the public towards public office-holders is one of indifference or contempt for the people 'feeding at the public trough.' And last, but not least, salaries do not compare with those offered in private employment for jobs demanding similar talents."

Changed Attitude Needed.—American government and especially American city government has undergone a revolution in the last century. The public is demanding more and better technical services of the cities. Yet the attitude of the electrorate has changed little toward public employes. Until it is realized that adequate and efficient public service demands trained experts instead of expert politicians, the city dweller will not get an adequate return for his taxes.

Factors That Must Be Considered in Valuing Real Estate

Considerations in Arriving at an Equitable Tax Assessment

By LEE I. HECHT
Associate Judge, Appeal Tax Court, Baltimore, Md.

WHAT the fairminded taxpayer wants is fairness and equality to all, and that each and every citizen, whether the owner of only his small home or of property belonging to one of our major corporations, is entirely satisfied when he or they realize that no preference whatsoever is being shown, but that all property is assessed on the same basis. A practice which has greatly improved the taxing system is to delegate a particular assessor and his assistant to a district with which he must familiarize himself and review annually, so that the taxpayer promptly receives the advantage of any change in conditions. The ordinary assessor endeavors to be fair and has no interest beyond that of seeing that all taxpayers, and they, of course, contribute to his salary, are treated on the same basis.

No Set of Rules Applicable to All Conditions. — Conditions in various communities are so vastly different that it would be hard to lay down a set of rules that would be applicable in all cases; and, therefore, there must be careful investigation and consideration given to local conditions in arriving at conclusions that would assist in appraising property for taxable purposes. The law in our State provides that property must be assessed at its fair and reasonable value. So frequently people get the idea that they are assessed 50 per cent or 66⅔ per cent of the value of their property. Should any such practice be followed, no one would gain any benefit because the same advantage would be given to each and every taxpayer, but what we endeavor to find is a fair value of the property. Now, what is value of the property? Certainly it is not selling price when forced by foreclosure or other public sale, but what price the property will bring at private sale, though no force be back of the sale. Of course, when property is sold and particularly when bought by a successful real estate operator, the impression very frequently goes out that it was bought cheaply and that if Mr. So and So paid a certain price for it, surely it is worth more. In fact, during the boom days, frequently prices pyramided in that a resale occurred on the strength of the operator who originally bought the property. This brings to mind a certain incident when I was attending an auction sale of valuable personal property at a nearby resort. A lady who had lost her pocket book in the crowd, which pocket book contained $100, promptly made her way to the auctioneer and instructed him to advise his audience of her loss, and to offer a reward of $50 for the return of the pocket book and its contents. Immediately after the auctioneer made the announcement, a zealous business man who was sitting in the front row of the auction, promptly arose to his feet and bid $75 for the return of the pocket book and its contents. So in real estate when one buys, even though the property may have been for sale for quite a long time, it immediately reminds another prospective purchaser that they have lost an excellent opportunity of getting a real bargain.

Elements in Connection with Values. —Again referring to value, we must consider several elements in connection therewith: the original cost, the selling price, going concern value, replacement value, income value, loan value, sentimental value, market value, cash value and possibily social value. These factors and possibly some additional ones must be taken into consideration in appraising for taxation of real estate.

In assessing a new building, where we have the original cost, it is most fair to assume that the contractor built it as reasonable as an ordinary prudent person could have built the same, particularly after competitive bids had first been secured; and, therefore, it is fair to assume the cost to the owner when the building is completed as a fair and reasonable cost; nevertheless, it is only right and proper to make a deduction of say 10 per cent from the total cost, which will cover commissions, bonuses, and certain exceptional and extraordinary fees, and by deducting the said 10 per cent a fair and reasonable value of the property is obtained. This gives us a fair price for the purpose of taxation.

Selling Price of Property.—Now, as to selling price of property we, of course, cannot take one particular or isolated sale where for some personal reasons the person may have paid more than the actual worth of the property, but upon having several private sales in a block or neighborhood of similar property it is most fair to average the several sales and in this manner ascertain the real value of the particular property in that neighborhood. In this connection I might inject at this time that where rows of houses are built, all of the same construction and design, containing the same number of rooms, that each and every one of the particular properties in the block must be appraised and, of course, assessed precisely at the same value. Corner properties of blocks most naturally have advantages which other properties of the same block do not have; and, therefore, the corner influence must be considered in arriving at the value of the same.

Going concerns, particularly of manufacturing concerns, have a much greater value than similar properties of non-going concerns, and wherein the said properties have been vacant and their utility wanting for a period of time.

Replacement and Income Values.—Replacement value is a serious proposition, especially wherein we must consider the added cost of building today as compared with the cost of building in years gone by, and wherein it is necessary to replace a building and the valuation for taxation is considered on this score, certain allowance must be made and provided for depreciation from the cost of replacement today and the cost of the building that was established in years gone by.

Income value applies in various ways as to the different classes of property. An illustration is offered of apartments wherein the owner must provide in some instances janitor service, elevator service, as well as heating, while in others only heating and no additional service is given. In the former class I believe that a gross income of 22 per cent to 24 per cent should be allowed for, assuming all apartments rented, in arriving at a fair value of the property, especially considering this element. While in apartments of the cheaper class, where only heat is provided and no modern refrigeration such as most apartments now furnish, then I believe a capitalization of from 18 per cent to 20 per cent is ample and fair to the parties of interest.

Let us also at this junction stop and consided the income value received from stores and retail establishments in general. When leases are made for such properties the amount of taxes that the owner is then paying is taken into consideration when entering into the lease, and an excellent provision

which is usually incorporated in leases, and which, I might add, should by all means be made a part of the same, is that any increase in taxes whether by assessment or rate should be borne by the lessee, and if this provision is provided for, then I feel that a fair return in assisting in arriving at the value of the said property, considering the income of the same, is 10 per cent to 12 per cent. Office buildings provide another class of property that we must give special consideration, and the rate per front foot that other buildings in the same community and particularly in the same neighborhood are charging and receiving, and the amount of space occupied must first be considered. Assuming that the building is filled and that there is a demand for similar space, I believe that a return of 10 per cent to 12 per cent on the income when service such as is given in the modern office building is provided is fair and reasonable.

Sentimental and Social Value.—Sentimental value is something that must be seriously considered, for restrictions are frequently provided for in properties, which restrictions have the effect of maintaining among a certain class of persons the value of the properties in that particular section. This applies in most instances to developments of the better class, and also we might consider sentimental reasons which frequently have the effect of having the property sell for more than it is really worth, when a person is willing to pay more than the actual value of the property solely because they want to reside next to a relative or close to a school, or for some extraordinary or exceptional reason. If sentimental reasons give an exceptional or extraordinary value to the property, then this value should not be considered by the assessor in appraising that property for taxable purposes.

Social value is analogous to sentimental value and should not be considered too strongly in arriving at a conclusion as to the value of the property.

Cash value is the value on which we should base our appraisement for taxable purposes, and when a person who has just purchased a property secures a fair and reasonable loan in the way of a mortgage on the same of 60 per cent or 65 per cent of the value of the same, it should have no effect as to helping to place the value on the property, because such a loan is an investment to the one from whom the money is secured and must be considered in the same category as a cash sale.

Valuation of Land and Improvements.—Another most important thought and one that I desire to call your attention is the difference between the valuation of land and improvements. After establishing the unit value of land in any particular block, all land in that block is assessed at precisely the same value per front foot, but, of course, additional value for corner influence. This method is fair to each and every owner wherein each and every front foot having the same depth is assessed at precisely the same value. Improvements cannot always be appraised with the same degree of certainty that we appraise land, because it is manifestly apparent that even though improvements appear to be the same, they are frequently quite different when thoroughly investigated. Land when unimproved does not have the same value as when improved, and I personally feel that unimproved land should be increased 33⅓ per cent when improvements are made upon the same, said improvements, of course, to be of a definite and permanent nature.

Acknowledgment.—The foregoing is an abstract of an address at the recent annual convention of the National Association of Real Estate Boards.

Sterilization of Tunnel Shafts

Chlorine is used by the city of Chicago for the sterilization of shafts of water tunnels which have become polluted by leakage from sewers.

The chlorination of shafts has been resorted to as an emergency measure on several occasions. Whenever "live" sewers adjacent to water tunnel shafts are being repaired or replaced to correct leakage into the shafts chlorination has been advised because of the relative rapidity with which pollution at the surface of the shaft may be carried down and contaminate the water passing through the tunnel. Studies on the time of penetration and the circulation of water in shafts of various depths have been made, using a salt solution and an electrical apparatus with a sensitive millivoltmeter to record the presence of this solution at various points in the shaft.

The method of chlorinating shafts is to connect a hose by a special fitting directly to a chlorine tank and lowering the hose to the bottom of the shaft. The gas is then turned on at a rate sufficient to prevent frosting of the tank and the hose raised gradually at a rate of about 2 ft. per minute. This practice has proven effective and practical and has been very helpful in connection with the tunnel pollution work.

New Jersey May Eliminate Cross Connections.—The State Board of Health of New Jersey will consider at its next regular meeting a proposed amendment to the state sanitary code, having for its object the elimination of pipe line connections between approved public potable water supplies and unapproved sources. Chief Engineer H. P. Croft has submitted to the state board a report recommending an effective change in the sanitary code, prohibiting the installation of new cross sections or by-passes between approved and unapproved sources of supplies. He also recommends the abolishment of existing conections before a given time, unless they are all of a modern type, readily made accessible for inspection. In such circumstances the report suggests the granting of temporary permits, renewable annually by the State Board of Health.

Method of Sterilizing a Tunnel Shaft by Chlorine; Also Shows Deep Sampling Apparatus for Obtaining Bacteriologic Samples From Shaft

The Protection of Impounded Reservoirs

Results of an Investigation of Recreational Activities

By HELMAN ROSENTHAL
Director, The Dallas Laboratories, Dallas, Tex.

THE writer has had the privilege of observing for several years the water from lakes in Dallas. The city has four sources of supply; deep artesian wells (which supply only part of the city), Elm Fork of the Trinity river, a small reservoir containing about 700 million gal. of water, and a larger reservoir containing about 5 billion gal. of water. The latter reservoir covers an area of about 1,500 acres and has a shore line of about 12 miles. Drainage from the surrounding country (which includes a number of dairies and one or two trash dumps) enters the lake; hunting and fishing in season is permitted, and no restrictions on boating. Bathing is not permitted, but undoubtedly a few mischievous boys could be found in the lake on a great many occasions.

That part of the city of Dallas which uses chemically treated water consumes about 14,000,000 gal. per day, 8,000,000 gal. of which comes from Elm Park and Bachman lake, and about 6,000,000 gal. from White Rock lake.

The latter lake was opened about 1910, and as stated above, boating, hunting and fishing are permitted; also considerable drainage from a few dairies gets into the lake. At no time, however, has the pollution either from the smaller or larger lake been so great that careful treatment would not produce an A-1 effluent.

The Questionnaire and the Replies.—The whole problem simmers down to the question, what is the limit of pollution that can be handled safely and economically by the various processes of purification at our command? The writer has sent out the following questionnaire to a number of waterworks men throughout the country:

1. What is the average count on Agar at 37 deg. C., 24 hours?
2. What is the average B. Coli content per 100 ml.?
3. What is the highest Agar count ever obtained?
4. What is the highest B. Coli content per 100 ml. ever obtained?
5. What is the average Agar count and B. Coli index in final effluent?
6. What is the average Agar count in tap water?
7. What is the B. Coli index of city tap water?
8. Under the most adverse conditions have you any trouble in meeting the treasury standards for pure water?

Answers were received from eleven cities, and since I failed to ask permission to use their names, I will just call them A, B, C, etc. The answers are summarized in Table I. The information regarding recreational activities follows:

A. City of about 900,000; water treated and filtered.

"My personal opinion is not to allow hunting, fishing and boating on the water shed, as there is a potential danger of a typhoid fever outbreak, which would be very hard to check. I am greatly in favor of keeping the public away from the water shed."

B. City of about 1,000,000 population; water treated and filtered.

The superintendent of filtration does not advocate hunting, boating and fishing, and has the following to say:

"It has always been my opinion that these sources of supply should receive the greatest amount of protection because while it is not the usual thing to suffer any pollution, there are rare occasions when epidemics of appreciable size are caused through carelessness."

C. A city of 800,000 population.

The superintendent has this to say:

"Regarding the matter of boating and fishing in our reservoir, we have never allowed hunting, fishing or boating on our property. We control 8,000 acres which we have made into a state game preserve."

D. A city of about 450,000 population.

The bacteriologist from D. had the following to say:

"Personally, I can see no objection to permitting hunting and fishing on a raw water reservoir on a large size reservoir."

E. A city of about 135,000 population. Water unfiltered and comes from impounded reservoir.

The city chemist of the city of E. states the following:

"With reference to boating, fishing, and hunting on watersheds, we have permitted these at ———— lake and up to the present time have had no trouble. I see no objection to the practice so long as it is properly controlled."

F. A city of about 160,000 population. Infiltration Galleries.

Regarding hunting, boating, and fishing, the chemist at this water works has the following to say:

"Owing to the fact that our water is collected entirely by means of infiltration galleries, we have no storage or impounding reservoirs—and therefore, feel that our experience or opinion on this matter would not be of much value to you."

G. A city of over one million population.

The city engineer of G. who answered the questionnaire states:

"Although we are not familiar with local conditions at Dallas, as a general rule this department does not favor the use of water reservoirs for recreational purposes."

H. A city of over one million popu-

Summary Table Showing Results in a Number of Cities in the United States

City	population estimated	Highest Agar Count 37° C. 24 hrs. 1 ml.	Highest B. Coli per 100 ml.	Average Agar Count 100 ml.	Average B. Coli per 100 ml.	Agar Count tap water 1 ml.	B. Coli per 100 ml. tap water	Water treated and filtered	Water chlorinated but not filtered
A.	900,000	70,000	100,000	300	600	0.1(?)	0.3	yes	....
B.	1,000,000	.....	.....	33	.....	2.	.....	yes	....
C.	800,000	31,000	1,000	175	750	2.	0.1	yes	....
D.	450,000	31,000	100,000	2,200	2,000	.....	1.	yes	....
E.	135,000	1,800	100	280	15	100	practically 0	no	yes
F.	150,000	50,000	10,000 (do not make lower dilution than 0.01)	1,901	3,300	0.81 (?)	practically 0	Infiltration galleries	?
G.	over 1,000,000	81,000	30,000 (McCrady No.)	584	40.8 (McCrady No.)	7	0.051 (McCrady No.)	no	yes
H.	over 1,000,000	.....	10,000	343	699	5	0.6	no	yes
I.	800,000	94,000	60,000	9,700	2,470	*380	1	yes	....
J.	160,000	over 10,000	.....	218	2,926	14	1.19	yes	....
K.	300,000	rather high	rather high	.....	.....	below 100	below 1	yes	....

*This high count due to passage through open clear basins and after growth. The effluent from the plant has an average count of only 23.

lation. Water chlorinated but not filtered.

The commissioner of the city of H. states:

"Boating and fishing is permitted in most of the lakes and reservoirs which constitute ———— water supply."

I. A city of about 840,000 population. Water treated and filtered.

The following is a statement made by the chief chemical engineer:

"Where water is to be treated and filtered, I can see no objection to fishing and hunting on the watershed. In district where no treatment of the water follows storage no such use of the watershed should be maintained and the hunters and fishers should be notified of the proper disposal of all waste and litter."

J. A city of about 160,000 population. Water treated and filtered.

The chief chemist of J. further states as follows:

"We have several small cities and villages on our watershed which contribute very largely to our raw water contamination. In your case I would say that only fishing, hunting and boating would do you little damage."

K. A city of about 300,000 population. Gets its water from a river. Water is treated and filtered.

No definite answers but to my personal knowledge this water will run very high both in count and in B. Coli. Boating, hunting and fishing is permitted, but not swimming, and this city has rarely to my knowledge ever failed to comply with the Treasury Standard.

In Dallas, as stated before, we are obtaining water from two lakes; one fairly good size containing approximately 5 billion gallons; the other containing only about 500 million gallons. In both of these lakes hunting, boating and fishing are allowed. Furthermore, there are a considerable number of camping sites on both lakes and they of course contribute to the pollution. Yet, the bacterial count as well as the B. Coli are very much less than our river water, hardly ever running over 100, most of the time considerably less than 100 B. Coli per 100 ml. We have not had at any time that I have had charge any trouble in producing a water considerably better than the U. S. Standard.

Studies of U. S. Public Health Service.—In my opinion the only criterion whether hunting, boating, and fishing or even bathing should be permitted is the load that the water purification plant can safely and economically handle. This is a problem that still needs solution. The work done by the U. S. Public Health Service on the Ohio River is of considerable value but in my opinion still insufficient in drawing definite conclusions.

In the review of Mr. Streeter of the U. S. Public Health Service, he states that the primary object was to study the limits of raw water pollution which are consistent with the production of effluents conforming to accepted standards of bacterial quality, having reference to water purification plants of the type found along the Ohio River and on other similar river systems serving as sources of purified municipal water supplies.

The secondary objective was to evolute the different facts subject to the control of the plant operator, which influence, directly or indirectly, the cost and bacterial efficiency of water purification.

The conclusions reached by the experiments at experimental plant at Cincinnati were as follows:

"That an orderly relationship exists between the bacterial quality of raw water and effluent—virtually unaffected by seasonal changes as raw water turbidity."

"The indicated maximum limits of raw water B. Coli are 100 per ml. for unchlorinated and 5,000 per 100 ml. for chlorinated water."

He states "that these conclusions, however, are subject to qualification pending further studies of other factors which have a decided bearing, in contrast with those which are involved in the purification of turbid river waters, such as exist in the inland streams of the United States."

Summary of Replies to Questionnaire.—Summarizing we find the following: All the answers with the exception of J. assert they never have any trouble in producing a water which meets the U. S. Standard. Even J. which states that they sometimes have trouble, have an agar count of only fourteen and a B. Coli index of 1.19 per 100 ml. In other words, it seems that almost regardless of pollution good results can be obtained. Please understand that I am certainly not advocating indiscriminate pollution; I am merely trying to analyze the situation in an unprejudiced attitude of mind with the hope that we can arrive at something definite.

It may be argued that it would be ideal to eliminate all possible pollution from our raw waters. Such a condition even if desirable, would be economical. In this connection it must also be remembered that there are vast areas in the United States that have no large bodies of water and to deny the citizenship the use of same is to deprive them of something very essential to their well being.

Conclusion.—In conclusion, I wish to state that in my opinion we can allow freer use of large reservoirs, provided certain precautions are taken, than has been hitherto thought advisable. Especially is this true where lime is used in the treatment, and chlorination is resorted to. It of course, also means that the man in charge of the Water Purification Plant must be capable, and know at all times the kind of raw water he is getting and the quality he can produce. He must be able to interpret results and know how to apply the facts gathered. He must know something about the factor of dilution, the effects of sedimentation both in the reservoir itself and after the treatment with the chemicals, and other data which will aid him in his decisions.

As mentioned before, there may be some additional cost in treatment of polluted raw water, but the additional cost involved in producing a safe effluent should certainly not cause the community to legislate against the use of the watershed or the water itself. Someone, whose name escaped my memory, well expressed it—"So long as we huddle ourselves together in large cities, we must pay the penalty of concentration." Where water is a scarcity, people have a right to demand that they be allowed, at least, limited use of the water and at the same time demand from the men in charge of the purification plants to produce an A-1 effluent.

Acknowledgment.—The above is an abstract of a paper presented at the 1928 convention of the American Water Works Association.

X-Ray to Be Used for Finding Defects in Trees

The Eastman Kodak Co. is conducting experiments in examining trees with the X-Ray to discover defects and estimate their seriousness and extent. The danger of allowing seriously defective trees to stand may be eliminated by the X-Ray if the experiments work out successfully, according to the research laboratories of the Eastman company. The X-Ray may also prove valuable in saving trees which might be cut down on suspicion of being unsafe. X-Ray examinations can be used on wood poles supporting telephone and electric lines as well as on living trees.

The X-Ray examination of trees and poles gives much more information than the ordinary method of inspection, according to Eastman company officials. It is believed that cities and public service corporations, who may be subject to heavy damage suits from falling trees or poles, as well as commercial tree surgeons, will be interested in the X-Ray examination of trees.

X-Rays have already been used in examining raw wood and wood structures for defects. One important instance of this has been the inspection of the wood parts of airplanes.

X-Ray photographs of 1-in. slabs cut from decayed trees have been made by the Eastman company and show a great deal of interesting detail. It is believed the X-Ray examinations will be useful in the study of the structure of tree decay.

St. Louis to Vote on Airport.—A special election will be held at St. Louis, Mo., to vote on a $2,000,000 bond issue for a new airport.

Water-Cement Ratio Proportions On City Paving Job

Methods at Lawrence, Kan., Described in Kansas Municipalities

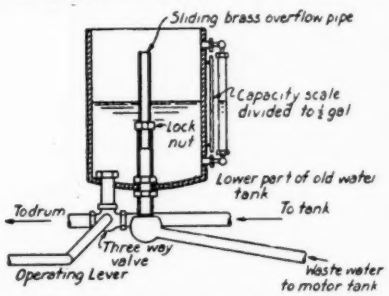
By C. T. HOUGH and HOLLAND WHEELER
City Engineer and Construction Engineer

DURING the past season, the engineering department of the city of Lawrence, Kan., used the water-cement ratio method of designing concrete mixes for city paving, to try its practicability.

Mixes Designed Under Old Specifications.—The main difficulty at first lay in the 1:2:3½ mix specification, drawn up before the pre-determined strength method for mixtures was contemplated. This was brought to the attention of the city commission and a special meeting was called to devise a plan by which water-cement ratio could be used on the summer paving program. After deliberation it was decided to design water-cement ratio mixes under the old specification. These mixes, however, were to aproach very nearly the same volume as the 1:2:3½ mix, which meant that the 3,000-lb. strength recommended for paving work must be exceeded in some instances. The following restrictions were also placed. (1) No mix, based on dry, rodded volumes was to exceed 1 part cement, 2.2 parts fine aggregate and 3.6 coarse aggregate. (2) The cement factor for 1 sq. yd. of 7-in. concrete was to approach very nearly 1.17 sacks. Some of the designed mixes exceeded the above proportions and in some cases mixes were reduced arbitrarily to meet requirements. At the close of the season, however, the excellent results obtained showed that the restrictions placed by the commission were very fair and sound.

Extra Equipment.—The contractors handling all of the season's paving work were Penny & Baldwin of Ponca City, Okla. The only extra equipment required by the contractor was a set of batcher-plant scales for a bin and a calibrated water tank. This tank was built under the supervision of the company engineer. The tank was used on the 21-E paver, with which all the slab was placed. Another tank very similar in design was built for the small stationary mixer used for curb and gutter work. As the base and top mixtures required different amounts of water, the tank had to be supplied with two overflow pipes. By setting either overflow pipe at the calibrated elevation on the tank, any desired amount of mixing water could be obtained. This method of apportioning water proved very satisfactory on both the large and small mixer.

In the matter of equipment the engineering department was not as fortunate as the contractor. After a study of the testing equipment employed in the laboratory, the following equipment was purchased: (1) Set Buffalo Scales, 250-lb. capacity, upper beam graduated to hundredths of pounds, lower beam graduated to pounds. These scales were of the platform style. (2) Screen shaker, constructed at a local carpentry shop. It may be stated, however, that most of the tests were conducted in the state laboratory. This was necessitated by the late arrival of some of the city equipment.



This plan although diagramatic will give some idea of the water tank arrangement. The tank was fastened with tie rods to the channels on top the mixer.

Water Tank Arrangement on 21-E Paver

Standard Tyler sieves number 4-8-14-28-48 and 100 were assembled for the sieve analysis of fine aggregate. Several paint cans of 2 to 5 gal. capacity were cleaned and calibrated. These cans were used in making unit weight determinations. With the addition of several flat cake pans and two refrigerator pans the laboratory equipment was complete.

The field equipment consisted of the following: Four standard 6x12-in. steel cylinder moulds. Each cylinder was provided with a ⅜-in. faced steel plate for cap and bottom of cylinder. The tamping rod was a ¾-in. steel rod, 18 in. long with one end rounded to form a bullet nose. A trowel with a square end, a spatula with a 1½-in. blade were also included.

Preliminaries in Designing the Mix.—In collecting preliminary information for the design of a mix, care was taken to employ methods endorsed by the American Society for Testing Materials. In a sieve analysis of the coarse aggregate, a sample of 75 to 125 lb. was taken from the loading bin. This sample was weighed wet, dried and reweighed to obtain the per cent of moisture. After drying, the sample was passed through sieves ranging from 2½-in. to the No. 8. Dust passing the No. 8 was recorded as "Pan." The total weight retained on each sieve was recorded and the "fineness modulues" calculated. The fine aggregate was handled in the same manner.

As 6x12-moulds were used, all unusually large rock fragments were thrown out in casting a cylinder. Each was filled in three layers and each layer was rodded. The side of the specimen was then spaded with a spatula to insure a smooth surface free from honeycomb and the top was struck flush with the mould and the specimen allowed to set for three hours. As soon as the cylinder was cast a batch of paste for capping was made up and also allowed to set for three hours. At the end of this period the paste was retempered and placed in a mound or cone shape in the center of the cylinder. The steel cap was then forced down on the paste until contact was made with the rim of the mould. After 24 hours the form was removed and the cylinders were stored in moist damp sand until a short time before testing. The bulk of the slab work was located in two districts, one in the northwest part of the city, the other in the extreme south portion.

Central Proportioning Plants.—This necessitated the construction of two central proportioning plants. The plant was laid out in two complete units, one for the handling of curb and gutter work, the other for slab. The curb and gutter unit consisted of a steel bin divided for the separation of rock and sand. Below the bin, and supported by the bin legs, was a platform on which a small 1-sack mixer was mounted. Above the mixer was a hopper in which the material discharged from the large bin was weighed. The cement platform was at one side, but integral with the mixing platform. Concrete was discharged from the mixer directly into the tracks.

A wood bin of about the same capacity and design as the steel bin was used for the slab unit. This was erected some 50 ft. north of the curb and gutter plant and was served by the same road. Below this bin and suspended on the lever arms of the batcherplant scales were two hoppers for weighing the coarse and fine aggregate.

The coarse aggregate pile was a source of considerable trouble at the beginning of the season. Shortly after unloading the sixth car of rock, the large traction gear on the crane was broken, necessitating the piling of ten or twelve cars of rock from one location. This resulted in a cone shaped pile with a great deal of coarse rock at the bottom and mostly fine at the top. In loading the bins the crane operator had great difficulty in keeping a uniformly graded rock. This in turn affected the designed mixes and on first assumptions was thought to have caused a great part of the trouble in maintaining a workable mix with a constant quantity of water.

Designing the Mix.—The first mix was designed for a "fineness modulus" of 7.50 for rock and 2.33 for sand. Excellent results were obtained with this mix when the rock gradations were uniform. Occasionally poor graded rock and variations in moisture in the sand would cause the mix to be either barely workable or too wet. It was soon determined however that the moisture content of the sand had a far greater effect on the mix than the rock gradation. The wide variation of the moisture in the sand in consecutive batches was due mainly to an inadequate stock pile to which sand of different degrees of wetness was added daily, the loads at times varying as much as three per cent in moisture content.

The mix was based upon dry, rodded volumes, the average being 1:2.31:3.50 for a 3,000-lb. concrete having a 2-in. slump. These volumes were changed to weights, making the proportions 94 lb.; 260 lb.; 360 lb., to which the weight of the moisture in the sand was added.

The fineness modulus of the sand ranged from 2.30 to 2.66. A fineness modulus of 2.33 on sand was maintained in the batches using rock of 1½ to 2 in. maximum size. The fineness modulus of the rock ranged from 6.44 to 8.07, a considerable variation. As stated previously, however, the variation in rock fineness modulus did not have as much effect upon the resulting mixes as did the moisture content of the sand.

Conclusions.—As a result of the trial related our conclusions are as follows:

1. As the work progressed, both the contractors' and engineers' organizations became more experienced in the use of water-cement ratio and were more able to keep the mixtures under control; hence a more uniform concrete was obtained as shown by test records.

2. No appreciable saving in cost was made on this season's work due to the fact that the saving in cement was offset by increased engineering cost. This increased cost of engineering will be reduced in the future due to the experience gained during the past season.

3. The use of water-cement ratio will automatically increase efficiency about the plant, and will call attention to conditions which are ordinarily overlooked, such as inadequate and poorly graded stock piles, and mechanical features of plant equipment which may be obsolete or in bad repair.

4. When contemplating the use of water-cement ratio it is suggested that the minimum allowable strength be determined with a margin of safety in case there are no facilities for making cylinder tests as a check on the determinations.

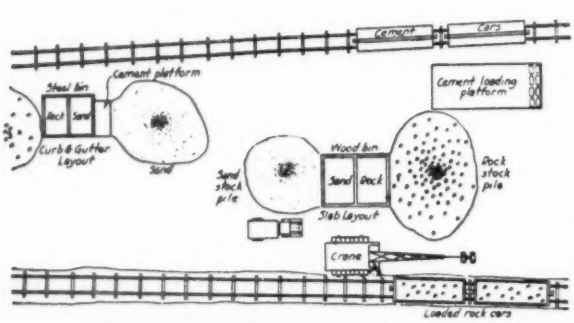
5. It is our intention to continue the use of water-cement ratio in the future so long as the successful bidder on the season's work is willing to cooperate and produce the desired results. However, contracts for the work will in all probability be drawn up with water-cement ratio as an alternate, until such a time that its use is more universally adopted by engineers and contractors in this line of work.

TEST CYLINDER RECORD

CURB AND GUTTER CYLINDERS

No.	Date Made	Date Tested	7 Day Strength	28 Day Prediction	28 Day Strength	Mix	Designed for
1	6-27-27	7-4-27	1260 lb.	2325 lb.	3060 lb.	1:2:4	
2	6-27-27	7-5-27	1750 lb.	3007 lb.	3100 lb.	1:2.4:3.3	3000 lb.
3	6-28-27	7-6-27	1828 lb.	3110 lb.		"	"
4	6-28-27	7-28-27			1900 lb.	"	"
5	6-30-27	7-7-27	1583 lb.	2778 lb.		"	"
6	6-30-27	7-28-27			2260 lb.	"	"
7	7-1-27	7-8-27	2118 lb.	3498 lb.		"	"
8	7-1-27	7-29-27			3200 lb.	"	"
9	7-2-27	7-9-27	1470 lb.	2620 lb.			
10	7-2-27	7-30-27			2950 lb.	"	"
17	7-9-27	7-16-27	2425 lb.	3905 lb.		"	"
18	7-9-27	8-2-27			3700 lb.	"	"
			SLAB CYLINDERS				
101	7-12-27	7-19-27	2335 lb.	3777 lb.		1:2.31:3.50	"
100	7-12-27	8-9-27			3620 lb.	"	"
104	7-19-27	7-26-27	2220 lb.	3620 lb.		"	3250 lb.
105	7-19-27	8-16-27			3520 lb.	"	"
106	7-22-27	7-29-27	3580 lb.	5375 lb.		1:2:3.5	"
107	7-22-27	8-19-27	1926 Mix		4750 lb.	"	
110	7-25-27	8-1-27	4060 lb.	2995 lb.		1:2.15:3.5	3500 lb.
111	7-25-27	8-22-27			4830 lb.	"	"
116	8-1-27	8-8-27	2750 lb.	4322 lb.	3750 lb.		
117	8-5-27	9-2-27			3100 lb.	1:2.11:3.79	3375 lb.
119	8-6-27	9-3-27			3950 lb.	"	"
120	8-6-27	8-13-27	1990 lb.	3330 lb.		"	"
131	8-8-27	9-10-27			3400 lb.	1:2.30:3.41	"
132	8-18-27	8-25-27	2370 lb.	3830 lb.		"	"
137	8-22-27	9-13-27			3510 lb.	"	"
138	8-22-27	8-29-27	2230 lb.	3640 lb.		"	"
145	9-13-27	9-20-27	2810 lb.				
146	9-13-27	10-4-27			3350 lb.	1:2.13:3.60	"

Test Cylinder Record Sheet. Comparison Can Be Made Between the Designed Strength and the Strength Actually Secured



Lapout of Double Central Proportioning Plant

Increase in Property Valuations Due to Paving

The Toledo City Journal cites the following case showing the increased valuation of abutting property due to paving:

At the request of the president of Queens Borough, New York, a city engineer made a careful study of the valuation of all property lying along two streets before and after paving. In the case of Liberty Ave., the paving cost $152,552. Within four years the value of the property increased by $1,400,000, or nearly 10 times the cost of paving. The Ditmars Ave. paving cost $41,007. Within four years property abutting this pavement increased in value over $8,000,000. The estimated normal increase was $1,500,000, so a net increase of $6,600,000 was attributed directly to the new pavement.

Swimming Pool Dimensions for Officially Recognized Competion

Proportions for Pools Based on Regulations of A. A. U.

THE following data, compiled by the Portland Cement Association from the rules of the Amateur Athletic Union of America, gives the regulations which must be observed in the construction of a swimming pool in which can be held championship events.

The rules for swimming are analogous to those of baseball, tennis, billiards, bowling, etc., in that the dimensions of the field of play are fixed.

The restrictions laid down for swimming are not published in any summarized form, but occur here and there in the "Official Athletic Rules and Handbook" of the Amateur Athletic Union of America—commonly called the "A. A. U."

The rules of the A. A. U. which apply are quoted below.* It will be observed that no definite pool sizes are given. Following the A. A. U. rules will be found some comments on pool sizes which are commonly used.

Swinning, Diving and Water Polo Rules.—All national championships and all open amateur swimming and diving competitions held in the United States are conducted under the following rules. These rules are practically the same as the international rules under which Olympic Games competitions are conducted.

The Bath.—The end walls of the bath shall be parallel and vertical, and so constructed that the competitors can push off in turning with the hands or feet. The walls shall extend at least 3 ft. below the surface of the water.

The starting platform shall not exceed 2 ft. 6 in. in height from the level of the water for indoor competition; in open water it shall not exceed 5 ft., but in either case the height must not be less than 18 in. The surface of the starting platform should be covered with cocoanut matting or some similar material.

The Course.—For competition in open water, the course shall be marked off distinctly and visibly. The starting and finishing lines shall be at right angles to the course, and must be firm. There shall be turning boards at both ends of the course, which shall be as wide as the course, extending not less than 3 ft. under water and 12 in. above surface. If the finish is not at the end of the course, it must be at a firmly fastened pole or rope suspended not less than 2 ft. above the surface of the water, and decorated with streamers or flags so as to be visible to the contestants. In a long distance straightaway swim the finishing line must be not more than 100 ft. in width.

The Race.—For all free style and backstroke events each competitor shall have at least 5 ft. of clear space unobstructed by steps, ladders, fountains or overhanging pieces which will interfere with swimming or turning. For breaststroke events each swimmer shall have a 7-ft. lane. The referee shall see that this rule is strictly enforced.

Plunge for Distance.—The maximum height of take-off for the plunge for distance shall be limited to 18 in. above the surface of the water.

A line may be made or painted along the bottom of the pool or tank to enable the competitors to guide themselves.

Championship Events.—Indoor championships shall be held in enclosed baths not less than 20 yds. in length.

Outdoor championships shall be held in water not lower than 62 degrees in temperature, and indoor championships in water 70 to 78 degrees.

Records

In swimming competitions Amateur Athletic Union records shall be recognized over the following distances:

Free Style.—50, 100, 150, 220, 300, 440, 500, 880, 1,000 yards and one mile.

Backstroke.—100 and 150 yards.

Breaststroke.—100 and 220 yards.

Relay Racing.—Club teams of four and five men, each to swim equal distances of 50 and 100 yards.

Plunging.—The time consumed in plunging distances of 60 and 75 ft., and the greatest distance covered in one minute.

There shall be three records for each distance in yards, recognized as American Amateur records. They shall be (1) 20-yard pool records, (2) short-course records (made over courses 25 yards up to 50 meters, approximately 55 yards), and (3) long-course records (made over courses 50 meters and up).

For 100, 200, 300, 400, 500, 1,000 and 1,500 meters free style, 100, 200, 400 meters backstroke, and 100, 200, 400 and 500 meters breaststroke, only short and long-course records will be recognized.

Only long course records shall be accepted as records for distances exceeding 500 meters. Twenty yards bath records shall include all records made over any course less than 25 yards, but at least 20 yards in length.

American Amateur records can only be made in still water, or in tidal water where the swimmer has not been aided by the tide.

The course must be measured at the time (of record trial) and certified correct by a surveyor or a duly qualified official or approved by the swimming committee.

Amateur Athletic Union Regulations for Diving

Based on International Amateur Swimming Federation Rules, with slight changes to meet conditions in United States.

General Rules for All Diving Contests.—Dives are either springboard dives, or dives from high, rigid platforms.

Special Rules—Springboard Diving

The Springboard.—The diving boards used for the contests in springboard diving shall be 3½ ft. and 10 ft. above the water level; they must be slightly elastic and at least 13 ft. long and 20 in. wide, covered with cocoanut matting, and fixed in such a way that the front of each board projects at least 3½ ft. beyond the edge of the bath.

Depth of Water.—The depth of the water underneath a 10-ft. board shall be at least 12 ft. and underneath a 3½-ft. board at least 8 ft. (This depth is urged to encourage the construction of pools of greater depth.)

High Board Rules

Diving Platforms.—Diving competitions should be performed:

From rigid platforms not less than 15 ft. long, 6 ft. wide, covered with cocoanut matting, and fixed free from spring, the back and sides surrounded by a handrail, the front of each platform projecting at least 3½ ft. from the edge of the platform immediately underneath, at standard heights of 12 to 18 ft., 18½ ft. to 24 ft., and over 24 ft. above the surface of the water. Maximum height 36 ft. For women's competitions the maximum height shall be 24 ft.

Depth of Water.—The depth of water at the point of entry shall be not less than half the height of the platform from which the dives are to be made, with a minimum of 12 ft. From heights of 32 ft. and over, a greater depth of water than 16 ft. is not required.

Water Polo

Field of Play.—The distance between the goals shall not exceed 30 yards or be less than 19 yards; the width shall not be more than 20 yards and shall be of even width throughout the field of play. The two-yard and four-yard penalty lines and the half distance shall be clearly marked on both sides of the field of play.

Depth.—The water shall not be shallower than 3 ft.

Goals.—Goal posts shall be fixed at each end of the field of play. These

*From Spalding's Athletic Library.

must be at least 1 ft. from the end of the bath or from any obstruction. The width between the posts to be 10 ft., and the cross-bar to be 3 ft. above the surface when the water is 5 ft. or over in depth; when the water is less than 5 ft. in depth, the cross-bar to be 8 ft. from the bottom. Nets must be attached to the goal posts in such a way as to close the whole goal area, and hang below the surface of the water. The back of the net must be at least 1 ft. behind the goal line and hung from the height of the cross-bar. Goal posts and nets must be provided by the home team.

General Considerations

It is easily seen that the A. A. U. rules quoted above are not general in scope as to pool sizes, but are specific where limiting dimensions are necessary for the sport.

A pool should conform to the limitations quoted above if major swimming events are to be sought as attractions, and if such a pool is to be built, the rules quoted become design data.

The sizes of indoor pools vary considerably, but the following range is fairly inclusive:

20x60 ft.	20x75 ft.
25x60 ft.	25x75 ft.
30x60 ft.	30x75 ft.

It will be observed that the lengths are all an exact number of yards. Nearly all the events are a certain number of yards, and that accounts for the length-in-yard preference. Also, five lengths of a 60-ft. tank equals 100 yards, and four lengths of a 75-ft. tank equals 100 yards. The widths are multiples of 5 ft. because 5-ft. swimming lanes are used for the majority of events.

Pennsylvanians Prefer 1-Family House.—Of 19,237 families in Pennsylvania provided with new homes in 1927, 14,406 were housed in 1-family structures. Seventy-five per cent of those who built or bought new houses during the year preferred 1-family dwellings. These facts were brought out in a report made by William J. McGuire, Director of the State Bureau of Statistics, and show that $184,162,848 was spent for new construction during 1927, of which $97,443,991, or 52.9 per cent, went into the building of 1 and 2-family dwellings, apartments and hotels and lodging houses. But of all the expenditures in this class for 1927, 71 per cent went for the construction of 1-family dwellings, 6 per cent for 2-family homes, 19 per cent for apartment houses and 4 per cent for hotels and lodging houses.

Street Sanitation Officials to Meet in October.—The 9th annual conference of the International Association of Street Sanitation Officials will be held in Toronto, Canada, King Edward Hotel, Monday and Tuesday, Oct. 8th and 9th, 1928. A. M. Anderson, 10 South LaSalle St., Chicago, Ill., is secretary.

Many Uses of Portable Deep Drill Rig by Engineering Department of Los Angeles

An all-steel portable drill rig is used by the Survey Division of the Engineering Department of the city of Los Angeles, Calif., in making deep test holes. This equipment drills a 6 to 12 in. hole to a maximum depth of 600 ft., using casing, where sufficient clay or hard rock is not present to insure firm walls. This casing is all salvaged as soon as tests are completed and is used again and again, except in the case of permanent wells, which are desired for tests of ground waters. Holes are drilled to rock or equivalent formation to meet requirements and through it, when necessary to determine the substrata.

The many uses to which this drill rig were put during the past year were outlined as follows by A. D. Campbell, Engineer Sewage and Field Work, in the report of the Engineering Department for the fiscal year ended June 30, 1927:

Forty tests have been made for the bridge department to determine the formations on which abutments and piers must stand.

Thirty-three tests for the sewer department to ascertain earth formation to be expected in excavating for tunnel work, which findings enabled contractors to give more intelligent bids.

Fourteen holes were sunk for the legal department in determining land values based on depth of commercial deposits of sand and gravel.

Eighteen special tests were made covering general conditions, water level and formation.

A total of 105 holes, averaging 32 ft. in depth were logged.

Tests have been successfully made of formations underlying 80 ft. of quicksand in the Los Angeles river at Newell St. Footing tests were made for the Glendale Hyperion Viaduct under quicksand and bog conditions.

From the data shown by these test holes it was decided to use concrete piling under certain of the abutments and piers, and to omit piling in other cases. Because of these tests the designers were able to anticipate with reasonable assurance the foundation conditions which would be encountered.

Exact information pertaining to the subsoil conditions under water has been made possible by the use of this equipment, through gravel and rock to depths not practical with hand tools.

Work has been done in 26 sections of Los Angeles without tearing up the pavements or blocking traffic with great mounds of dirt.

Geological conditions, locally, are very broken and irregular, especially in relation to surface work, resulting in marked changes in formation in but a few feet of distance. An example of this is furnished by the several changes in the channel of the Los Angeles river during the history of the city. The old channels have been covered with clay deposits and fills of every conceivable kind, making it necessary that actual existing conditions be ascertained for the design of new work in these sections.

Things not on the records are sometimes discovered, as was an uncharted telephone cable at 4th and Hill Sts., which had been laid around rather than through the manhole. The drill found it and put it on the map, along with impaired phone service on over 3,600 pair of lines.

In testing for footings for the new First St. Viaduct over the Los Angeles river, no water was encountered until 30 ft. below the level of the water in the river channel, although only 25 ft. from its edge. At Pacoima Ave. in the San Fernando Valley, a clay deposit was found in the center of the river, while on either side were deep deposits of sand and gravel.

In the Newell St. tests, before mentioned, on the west side of the river, nothing but quicksand was encountered to a depth of 100 ft., while in a hole 125 ft. east, at the center of the present channel, clay was the predominating formation. On Greensward Ave. near Glendale, surface water at 4 ft. was the rule of that section, yet a test hole 22 ft. deep, located 59 ft. from a well, developed no water.

The plane of any given formation is easily traced by drilling three or more holes, as was done in gathering data for the proposed Victory Park condemnation. These data disproved valuation estimates for damages claimed and will effect a saving to the city of many thousands of dollars, if this project is completed.

During the construction of a curved tunnel on Section 36 of the north outfall sewer, a shaft was desired near the center of the work through which to drop a plumb line from the surface to check the accuracy of the alignments. The well rig was called to do this work and in a few hours had a 35-ft. hole through to the tunnel at the desired point.

In the Venice canal zone, no record of previous subsoil exploration had been kept. The drilling rig furnished the first authentic record of underground conditions for building foundations, drainage, and method of controlling ground water.

The uses of this equipment are varied, but all subsoil conditions for any purpose, can be quickly determined by this method. To date this rig has filled every order and completed every hole started under any condition, furnishing the information desired in full.

Filtering Materials for Sewage Work

Notes on Kind, Size and Depth

By N. T. VEACH, JR.
Consulting Engineer, Kansas City, Mo.

THE importance of proper selection of filtering materials for use in sewage work is apparent from the fact that there are, at least, 700 sewage disposal plants in this country using some kind of filtering material, exclusive of that used in sludge-beds. These plants are serving an approximate population of something like 5,500,000 people. The constantly-increasing urban population, and the somewhat slow but steadily-growing sanitary conscience on the part of the public, generally, that it is proper and necessary to dispose of its sewage and other wastes in an adequate manner, means that the selection of proper material to use in the construction of sewage-disposal plants will, in the future, constitute a very important phase in sewage disposal.

Kinds and Quantities of Filtering Materials.—Filtering material for sewage work can be divided into two general classifications, namely, coarse-grained and fine-grained materials. Coarse-grained materials are used in trickling filters or contact beds. The following materials have been used for this purpose: (1) Limestone; (2) trap rock; (3) quartzite; (4) granite; (5) broken slag; (6) broken smelter retorts; (7) wooden slats; (8) brush; (9) gravel; (10) dolomite; (11) coke breeze; (12) flint; (13) cinders; (14) coke; (15) sandstone. Of the above materials, limestone has been used most extensively. Studies made by the Committee on Filtering Materials, of the Sanitary Division of the American Society of Civil Engineers, indicate the following quantities of different coarse-grained materials in use in the United States:

	Cu. Yd.
Limestone	583,300
Trap rock	301,500
Granite	216,300
Quartzite	15,300
Gravel	28,100
Flint	1,200
Crushed stone (kind not given)	10,500
Slag	15,140
Cinders	3,100
Coke	5,200
Blue rock	2,400
Coke breeze	3,000
Crushed retorts	2,700
Joplin chats	200
Miscellaneous	5,200
Total	1,368,900

Relative Merits of Different Materials.—The progress report of the above committee (Proceedings American Society of Civil Engineers, April, 1927) shows that 30.7 per cent of the trickling-filter plants investigated showed disintegration, and 37.4 per cent showed clogging. Some of the clogging troubles are, no doubt, due to overloading, and character of applied sewage, but a large number are due, primarily, to the disintegration of the filtering material. The committee referred to expects to carry on further investigation, including quite extensive testing, in order to get some definite data on the relative merits of the different materials. Until some definite data are available, it will be necessary for those designing plants to pick the best material available, within reasonable cost. Such materials as granite, trap rock, quartzite and gravel have proved uniformly satisfactory, although there are places where some of these have shown disintegration. A number of plants using limestone have operated over a period of several years without noticeable disintegration. An interesting fact worth mentioning is, there is one plant, using broken sandstone, that has been in operation something over twelve years, without showing any appreciable disintegration. Of course, the best materials are not always available within the limits of reasonable cost, and it is necessary to use the best material at hand. In several places, this situation has been met by placing on the top of the filter bed, from 6 in. to 1 ft. of material known to withstand disintegration. It has not been definitely determined just how far down into the bed the weathering or disintegration goes, but it appears that it does not go very far, at least, for several years of usage.

Sprinkling Filters at New Sewage Disposal Works of Decatur, Ill.

Size of Material.—In regard to the size of material for use in trickling filters and contact beds, the practice in this country has varied over a wide range. These sizes range from a grading of ¼ in. to 2½ in. to one of 2 in. to 3 in. The ideal material would be the smallest size that would operate without clogging. The smaller the size, the greater area of stone available for contact and the formation of bacterial film or jelly. Uniformity of size is also an advantage. In practice, it is difficult to obtain a satisfactory stone without screening. Ordinarily, a grading of 1½ in. to 2½ in. will give best results; but slight variations from these sizes are possible, if the screens at the quarry from which materials are obtained do not give this exact grading. A minimum size of not less than 1 in. is advisable.

Depth of Filters.—In regard to depth of filters for trickling-filter installations, the practice in this country, as in the matter of sizes of material, has varied considerably. The depths have varied from 4 ft. to 10 ft. Usually, the depth of filter is determined, largely, by the amount of head available. Where head is not a determining factor, the problem becomes an economic one, qualified by the probable bacterial efficiency, which varies, depending on the character of sewage to be treated. A greater depth will ordinarily result in lower construction costs. The limits of depth are: the ability properly to ventilate the bed, the clarity of the settled sewage to be

treated, the character and size of filtering material, and evenness of distribution. A majority of the existing plants have been built with a depth ranging from 5 to 7 ft. Where ample head is available, practice seems to have been to use a depth ranging from 6 to 9 ft.

The above discussion of kinds of filtering material for trickling filters applies, in a general way, to material for use in contact beds. There has been a greater tendency to use such materials as coke, clinkers, cinders, broken brick, broken pottery and the like in trickling filters than in contact beds. This may be due to some extent, to the fact that smaller sizes can be used in contact beds. Also, there has been a tendency to favor materials having as porous structure as possible, on the theory that the bacterial film or jelly will form quicker and adhere better to such material than to that having smoother surfaces.

The necessity of selecting material that will withstand weathering and disintegration is, perhaps, more important in connection with contact beds than in trickling filters, due to the fact that a smaller size has ordinarily been used. The possibility of clogging and poor ventilation are also greater. There is a tendency to increase the size of material for use in contact beds, as evidenced by a number of the later installations.

Depth of Contact Bed.—The depth of contact beds is influenced by the same general principles that apply to trickling filters, such as economical construction, obtaining proper ventilation, available head, etc. Best evidence indicates that the bacterial efficiency is not affected by the depth of the beds. As more surface for contact is available with smaller-sized material and proper ventilation is harder to get with smaller sizes, practice, in this country and abroad, has been to use shallow depths compared to that used in trickling filters. These depths have ranged as low as 3 ft. and even less. The majority of plants have beds ranging from 4 to 6 ft. in depth, and, unless there is some unusual condition, such as having a settled sewage to treat which would have some unusual tendency toward clogging, depths within this range should be satisfactory.

Fine-Grained Filtering Material.—Fine-grained filtering materials in sewage work consists almost entirely of sand. Sand is used in intermittent filters and in sludge beds. There are something over 300 intermittent sand sewage filters in the United States, of which, perhaps, 15 per cent are serving institutions or industrial establishments. This type of secondary treatment gives, perhaps, the best results of all types of plants. However, they require considerable attention to keep the beds in proper working condition, and require a great deal more area than the other types.

Sand is also used in most sludge beds, and it is probable that the yardage of sand used in such beds equals that in intermittent filters, as a majority of plants of all types include them.

There is not a great deal of information on the proper grading of sand for use in intermittent sewage filters, or in sludge beds. There are many instances of clogging, some due to improperly graded sand, some to overloading, and some to the applied settled sewage, especially where it contains any appreciable amounts of fatty substance, or other waste having a tendency to clog the beds.

In many places natural deposits of sand and gravel are used by grading surfaces, and arranging for intermittent dosing upon the different parts of the bed or beds. Where natural deposits of material are not available, it is necessary to build artificial beds, using sand obtained from the nearest available supply which will meet the requirements set forth in the specifications. Sand containing clay, loam or silt, or that which contains too much fine material, will not give satisfactory results. The bed not only acts as a strainer, but also acts as a breeding place for oxidizing bacteria. Ventilation is vital for successful operation. An investigation of the requirements as to grading by different state boards of health, indicated a uniformity coefficient ranging from what is termed "as low as possible" to 3.5 mm., the majority being from 2.5 to 3.5 mm. Likewise the effective size ranges between the limits of .25 mm. to .50 mm.

Depths of Intermittent Sewage Filters.—The depth of intermittent sewage filters varies from 2 ft. to 5 ft. or more. A majority of the artificial beds range from 3 to 4 ft. above the underdrains. The depth of beds must be governed by the character of sand used. A slightly greater depth is desirable with fine sand as compared to coarse sand on account of the fact that fine sand will raise the water level above the underdrains by capillary attraction. Beds having fine sand, if sufficient in depth, will give best results bacterially, but cause more trouble in operation. The use of coarser sand, and operating at lower rates, will give satisfactory results, and less operating troubles.

The Committee on Filtering Materials of the American Society of Civil Engineers is carrying on an investigation of fine-grained materials at the present time, and it is hoped the results of its studies will give some additional information in regard to grading, etc.

Acknowledgment.—The above is a paper presented at the 10th Texas Water Works Short School.

How One City Started Its Original Community Safety Work

Opening the summer period of increased traffic hazards, the city of Asbury Park, N. J., planned a special "Safety Week" during May 14-21 for the widespread education of the citizens in accident prevention. The campaign was sponsored by the American Legion and the active work was carried on by a central committee made up of special committees from civic organizations, the chamber of commerce, the public safety commissioner, the mayors of the different boroughs, and representatives from the public utility companies.

According to "Public Safety" a high degree of cooperation was secured from all these organizations, the schools and private citizens, and the public safety commissioner has announced that the campaign resulted in a lower public accident record than the city has enjoyed during any week in three years.

Hundreds of posters were distributed by boy scouts, and large public safety posters were put up near the schools and at prominent street intersections. The trolley cars also carried big posters, and near the railway stations a huge bulletin board was set up, illuminated by a spotlight, on which statistics about accidents and special messages concerning safety were displayed from day to day.

A trolley car of the Coast Cities Railway was painted white, lettered prominently with safety slogans and was run continuously throughout the city. Daily the newspapers kept the idea before the people with instructive articles. The moving picture theaters cooperated with a safety picture; and public addresses were delivered at the civic organizations and the schools.

Boy scouts took an active part in the campaign, giving the life saving demonstrations in the natatorium, distributing literature, and on the final two days of the week they handed out 10,000 cards to jaywalkers. About 20,000 stickers bearing the message "Drive Carefully—I Do!" were placed on the windshields of cars parked in the city streets.

The schools played an important part in the week's activities. The teachers were given safety manuals from which they selected features on safety work which were handled along with the regular curriculum. About 150 safety posters were drawn by the children, and prizes were awarded to the 12 best posters.

Another activity of importance was a special inspection carried on during the week by the fire department of many buildings where fire hazards were suspected. Following the close of the campaign, a committee was appointed to carry on public safety work throughout the year.

Experiences With Crenothrix in Ground Water Supplies

Methods of Combatting Growth by Application of Chemicals

By K. W. BROWN
California Water Service Co., Stockton, Calif.

PREVIOUSLY published descriptions of the control and destruction of Crenothrix infections have dealt with water supply systems operating central pumping stations and purification plants. Under such circumstances it is possible to initiate means of treatment which, generally speaking, enjoy possibility of success. In California systems, however, with which the writer has had experience, the distribution mains are often supplied from wells in scattered locations. The problem of treatment is further intensified in that the automatic deep well pumps discharge directly into the distribution system.

Iron removal, in itself not always easy nor entirely satisfactory, is out of the question on account of the scattered arrangement of pumping plants. Systematic flushing, requiring a rather considerable labor expenditure, affords benefits that are merely transitory, and is of little effect insofar as improving general community opinion of the water's wholesomeness is concerned. Under such circumstances it becomes necesary to combat Crenothrix growths by methods that are, at least, comparatively inexpensive. All of which necessitates control or elimination by application of chemicals.

Experiences at Redondo.—At our Redondo plant we have a Crenothrix infested well discharging through a sand box to a storage reservoir. Until about a year ago somewhat inadequate control of the situation had been realized by means of treatment with copper sulfate and chloride of lime. The chemical solutions were prepared in oak barrels and fed directly to water passing through the sand box. This cumbersome and inaccurate system was replaced by a direct feed chlorinator. Following inauguration of chlorination at a rate of .60 p.p.m., we received an unusual number of complaints, but these lasted only four or five days, after which adverse comment was more or less of a rarity. Reduction of the dosage to .40 p.p.m. so as to avoid possible waste of chlorine, resulted in equally pleasant conditions. Attempts to further decrease the rate of feed were less successful as indicated by an apparent tendency toward poorer quality of water with respect to taste and odor. This spring, however, we experienced a revival of obnoxious water, particularly in one section of town located at a somewhat higher elevation than the average. As a result, it was decided to try sterilization of the offending well by pouring into it about 100 lb. of copper sulfate in solution. Introduction as a solution checks the possible action of crystalline copper sulfate on the well casing. After 24 hours the well was pumped to waste until clear water was obtained which, in this case, required a period of about 40 minutes. It should be noted that the efficacy of well sterilization in this manner is largely a matter of chance. The age and extent of Crenothrix infection, and location with respect to direction of ground water flow influence susceptibility to treatment. That such radical procedure is worthy of trial has been demonstrated at Redondo. Tufts of iron colored, Crenothrix bearing material discharging from the well have been eliminated and complaints have practically ceased.

Experiences at Bakersfield.—At Bakersfield we encounter, in some sections of the system, an annual epidemic of black water. The fact that those occur each spring leads one to the belief that they are indicative of seasonal changes in pipe growths of filamentous organisms common to ground waters. The recent disturbance at Redondo, also happening in the spring, is further evidence in favor of this theory. Disintegration of the plant at this time of the year is doubtless responsible for the unwholesome and discolored water. Remedy at Bakersfield has always been obtained by intensive flushing of the affected area for about two or three days. The community, at times other than this, is entirely unconcerned with the quality of water.

A Peculiar Well at Port Costa.—We have, in the Port Costa system, a rather peculiar well that has been the source of considerable difficulty. This well, which is drilled in more or less swampy formation, is about 480 ft. deep and has a capacity of 230 gal. per minute. Water pumped from it through a weir box to a storage reservoir carries large tufts of filamentous growths. This material is expelled in sufficient quantity to necessitate installation of a screen box for its removal. Two screens, 4x4 ft., of ¼ in. and No. 14 mesh respectively, are effective in removing practically all of the offensive appearing flakes. The system of screens is provided in duplicate so as to permit washing without interrupting operation. After passage through the screens the water is treated with both copper sulfate and chlorine, applied in the weir box at rates of .50 p.p.m. and .25 p.p.m. respectively. Although material washed from the screens produces foul and offensive odors as a result of decomposition, complaints regarding taste and odor have been entirely absent.

Experiences at Stockton.—The most obdurate and treatment defying ground water supply we have is that at Stockton. At the principal pumping plant, nine deep well pumps discharge through four inlets to a 2,000,000 gal. reservoir, from which water is pumped to distribution. Three other stations have a total of five automatically operated deep well pumps discharging directly into the system.

Microscopic examination of pipe samples collected from numerous locations indicated Crenothrix infection to be universally prevalent throughout the system. Leptothrix, a somewhat similar organism, was also observed in some abundance.

About eight years ago, following replacement of existing suction lift pumps with deep well equipment, the reservoir became infested with heavy filamentous growths and, at the same time, taste and odor became unduly apparent.

To combat these conditions, application of copper sulfate, followed by intensive flushing, was begun. This practice is still in effect, although flushing is confined to that necessary to relieve complaints, which are quite frequent in the vicinity of dead ends. The chemical is fed in solution to the main suction line at Station 1 at an approximate rate of one part in twenty million. Obviously, this is a minute dosage and is of doubtful value, if any. Reservoir growths have been successfully inhibited by spraying the walls twice weekly with a solution of bluestone. This solution, consisting of 6 lb. of copper sulfate in 15 gal. of water, is sprayed from equipment transported by boat. Water in the reservoir is lowered each time in order to expose the walls sufficiently.

Sterilization of two or three wells with bluestone in the previously described manner has been attempted, but no particularly beneficial effect has been observed. In this instance it is probable that subterranean conditions are not susceptible to such treatment.

Cleaning Water Mains by Chemical Means.—In order to investigate the feasibility of cleaning water mains by chemical means, we removed two sections of 4 in. pipe from service and subjected them to treatment. A solution containing .30 p.p.m. of available chlorine was passed through one section for a period of five days at a rate of 150 gal. per 24 hours. Examination of the pipe at the end of this time revealed no appreciable diminishing of the original ½ in. interior lining. This is contrary to results of experiments conducted by Stevens at Marysville who reports successful cleaning of Crenothrix lined pipes with solutions containing .20 p.p.m. of free chlorine. The second section of pipe was treated at the same rate, 150 gal. per day, with water containing .50 p.p.m. of copper sulfate. At the end of five days it was found that the majority of adhering material had been successfully removed, demonstrating thereby that chemical removal of conduit growths is not without possibility. The somewhat unsatisfactory nature of these results, as evidenced by the time and dosage required, has led to the abandoning of plans for cleaning the distribution lines by such means. It had been planned to isolate sections of pipe, dose them with chemical, and flush thoroughly at a high rate of flow before replacing them in service.

Experiences With a Swimming Pool.—A somewhat unusual opportunity to study the Stockton problem presented itself several months ago. A local swimming pool using city water had, for over a year, been experiencing badly discolored water. This was caused by the precipitation, some 20 or 30 hours after filling, of an iron colored amorphous substance which completely covered the bottom of the pool. Naturally, disturbance of this material produced an appearance which was, to say the least, uninviting. Believing this condition to originate within their own system, the management indulged in a thorough house cleaning and attempted various other methods of improving the situation, but to no avail. Finally, their woes were voiced to the water company. Microscopic examination of the precipitated material immediately showed the presence of filamentous algae, thus demonstrating conclusively the source of trouble. Large mains in the neighborhood were flushed as a primary remedial measure, but this failed to even slightly obviate the difficulty. The next step was to place a weighed amount of bluestone in a burlap sack and suspend it in the pool influent at the time of filling. This dosage, which amounted to 1.5 p.p.m., proved entirely effective in preventing deposition of the Crenothrix bearing material. Sometime later the management essayed economy by cutting the amount of chemical in half which, as was to be expected, brought about reappearance of the discolored water. Return to the original prescription again produced water of satisfactory appearance. Similar excellent results were obtained by means of an experimental chlorinator installation employing a dosage of 1.0 p.p.m.

Treatment with Chlorine.—Installation of chlorine equipment on the main suction line at Station 1, using an initial dosage of .25 p.p.m., was the signal for an immediate barrage of complaints. Consumers located on dead ends were particularly disturbed, and not without justification. Reduction of the dosage to .20 p.p.m. resulted no more favorably. It was then decided to operate the chlorinator during the day only, shutting down at night as soon as the low flow period occurred. This practice, which has now been in effect for some time, has been attended by little, if any, unfavorable comment. After continuing in this manner for several months it is intended to again chlorinate during the full 24-hour period. Naturally, it is too early to venture an opinion as to the probable outcome of treatment, although it is reasonable to expect some degree of improvement. Chlorination at the remaining stations, which are automatically operated, is not contemplated until sufficient data has been gathered at Station 1. Inasmuch as about 70 per cent of the total pumpage is from this plant, it is believed that the results obtained will be quite indicative of what could eventually be realized by treatment of the entire system.

In summarizing our experiences, it appears that Crenothrix infections in ground water supplies can be eliminated by application of either copper sulfate or chlorine in those systems operating pumping plants augmented by reservoirs of adequate capacity. It is advisable, however, in order to avoid occurrence of obnoxious conditions, that introduction of the chemical be made prior to the reservoir. For systems operating a series of scattered wells there is apparently little opportunity of destroying filamentous organisms; resorting to chemical treatment will occasion inevitably distressing features, the extent of which cannot be foretold. Combatting algae by chemical application to water pumped directly to distribution from a system of scattered wells is, therefore, nothing less than a gamble, with odds somewhat in favor of the Crenothrix survival.

Acknowledgment.—The above is an abstract of a paper presented at the 1928 convention of the American Water Works Association.

One Hundred and Four Illinois Cities Have Parks.—According to a survey by the Illinois Municipal League, 104 Illinois cities and villages now own municipal parks, ranging in area from Chicago's 4,487 acres to Steelville's half acre.

Los Angeles Plans for Industrial Growth

The Manufacturing and Industries Committee of the Los Angeles Chamber of Commerce has received a report of the Trackage Conference on the conservation of potential industrial lands, which is part of a movement to protect these areas in and about the city for future development.

This conference was formed about a year ago under the auspices of the Los Angeles Regional Planning Commission, with William J. Fox, chief engineer of the commission, as its chairman. It is participated in by representatives of the railroads, a City Planning Commission, Chambers of Commerce in the district, prominent industrial real estate operators and others. The object is to coordinate railway and highway future developments whereby a minimum number of grade crossings of highways will be made by railway industrial tracks and a sufficient width of interventing land area may be protected to accommodate industries with railroad spur tracks on the one side and highways on the other.

"Tentative plans for trackage layouts for five potential industrial areas have been submitted, showing the possibilities of connecting them with essential transportation services in various surrounding districts, Long Beach, Torrance, Compton, Watts and Culver City," says the Los Angeles Chamber of Commerce in explaining the program. "These rather ideal set-ups are dependent upon the execution by interested property owners of a mutual contract binding themselves to dedicate railroad rights of way for necessary tracks. It is provided, however, that, if no industrial development occurs and no complete system of tracks is laid within a certain period, the contract may be terminated, releasing all parties and lands.

"It is generally recognized that the widespread subdivision and residential development of property in the Los Angeles district has in many cases caused undue encroachment upon lands adapted for industrial development, and that highways in many cases have paralleled railways, choking out logical industrial use of much land which, if so developed, would give greater value even to adjacent residential areas."

Towns Need Competent Engineering Service.—In an address at the 4th annual convention of the League of South Dakota Municipalities, John E. Hipple, mayor of Pierre, S. D., pointed out the importance of having efficeint engineering service for municipalities. Mr. Hipple pointed out that many towns are unable to pay the salary of an engineer, and suggested that it is feasible for several municipalities to unite in hiring the services of a competent engineer or firm of engineers for the group.

Public Sanitation Work in Liverpool, England

Practice Outlined in Paper Before British Institute of Public Cleansing

By WILLIAM MUIRHEAD
Chairman Health Committee, Liverpool, England

UNTIL recently the area of the city was divided into 23 districts, but on the extension of the city in April last, when a further area of 3,553 acres was incorporated, opportunity was taken to revise this sub-division, with the result that there are now 20 districts. The total area of the city is 24,795 acres or, when the foreshore and bed of the river are included, it becomes 27,678 acres. In all some 1,500 men are employed on the operations in connection with house-refuse collection and disposal, and street-cleaning works.

House Refuse Collection.—A weekly collection is provided and the total quantity of refuse collected (including street sweepings) amounts to approximately 1,200 tons per day. A difficulty not experienced by many municipalities is caused by reason of the lay-out of the older portions of the city, for the house refuse from nearly three-quarters of the city (with a population of 879,982) has, owing to the fact that a large number of back passages have been laid out to a width of 4 ft., to be carried by the collectors an average distance of about 45 yd. Again, in dealing with houses built adjoining our boulevard streets, the cost of collection is increased, because in most cases dual streets are provided, the two streets being in many parts separated by an enclosed tramway track.

The type of receptacle most generally in use is a fixture wall bin, which when being emptied, is temporarily removed from the wall; some 86,000 of these fixture bins are in use, the size adopted being that which has a capacity of 3½ cu. ft.

Transport of Collected Materials.—The question of the type of transport to be used for the conveyance of the collected materials is one which has for some little time been occupying the attention of my committee.

Rather more than a year ago a report was submitted by the city engineer and one by the chief veterinary officer, in which figures were given showing the relative costs of conveyance by horse and by mechanical vehicles. In view of the fact that the majority of the horse-drawn vehicles were of somewhat old types, and that some of the comparisons were made with figures obtained from the use of certain recently-purchased low-loading motor vehicles, it was decided to have a number of relatively light low-loading horse wagons constructed. In order to ascertain the relative cost of transport by these different types of vehicles, tests have been arranged which are to extend over a period of three months.

The department has now in use some 156 carts having a capacity of from 30 cwts. to 2 tons, 50 motors varying in carrying capacity from 2 tons to 6 tons, including three steam trucks and two electric vehicles.

My committee are anxious to provide as becomes practicable more of the low-loading type of vehicles, for it is found that the work of our Gratuities Sub-committee is increased by reason of the old higher vehicles.

During the past month in the city council has placed an order for a tractor and four low-loading trailers, the four latter vehicles being horse-drawn during collection, and the tractor hauling the same to the point of disposal.

Disposal of Refuse.—The systems of disposal at present in operation are four in number, namely, by (a) incineration at destructors, (b) controlled tipping, (c) barging out and dumping at sea, (d) barging along the canal (or by rail) to farmers.

Destructors.—Until some 14 months ago the corporation had in use six destructors, each working two 8 hour shifts per day. About that time two of the oldest ones were closed, and of the remainder two were placed on a single shift per day. From the steam raised at these destructors electricity is generated and sold to the Electric Supply Department. The two destructors which were closed down had been in use for more than 27 years, and considerable expenditure would have been necessary if they had been continued in operation.

Controlled Dumping. — About 14 months ago this type of disposal, which had up till then only been used to any considerable extent in ordinary dumping on sites mainly outside the city, was, on the recommendation of the city engineer, considerably extended, and for the 12 months ending March 31st last the actual cost of disposal showed a saving of over $100,000 on the estimates. This appreciable saving was affected despite the fact that some 6,600 new additional houses were served during that year, and the total quantity of material dealt with showed an apparent increase of approximately 38,000 tons. The term "apparent increase" in referring to the total quantity of material is used as much of the material is not weighed before disposal.

In this method the material is deposited in layers about 6 ft. in depth, and covered with a good layer of soil, both on the surface and on any exposed side; the working face is kept as small as practicable, such face being covered each night. The layers are kept to definite levels, and as soon as possible a covering of grass is produced on the surface.

Dumping at Sea.—The corporation owns the "S.H.B. Delta," which is specially built for the purpose of transporting refuse to sea and for the dumping of the material out at sea. The vessel has a carrying capacity of 1,000 tons, but in view of the relatively light nature of much of the domestic refuse, the average load during the year ending March 31, 1928, amounted to 742 tons.

By Canal (or Rail) to Farmers.—Two of the corporation's cleaning depots are situated on the banks of the Leeds and Liverpool Canal. The corporation owns sixteen wooden barges, and in these the materials having a higher manurial value are transported along the canal and sold to farmers for farm purposes.

In addition to the corporation's fleet, some of the material is conveyed by rail in forty-six corporation railway cars to farmers—a quantity of about 7,000 tons per annum being disposed of in this manner.

Street Cleaning and Watering.—The total length of streets cleaned within the city is approximately 615 miles, some 40 miles of which are 120 ft. or more in width. The latter roadways are usually divided by a central strip, in many cases used for an enclosed tramway track, so that for comparative purposes our mileage of streets should be increased by the addition of a length equal to that of the dual roadways.

The system adopted for the central city streets is to have the same swept by day by orderly boys each having a length of from 200 to 300 yr., these boys traverse their routes usually about six times per day. Their trolleys carry two bins, and these are emptied two or three times per day into larger street-cleaning vehicles. These streets are watered, and swept by mechanical brooms, six nights per week, one of these mechanical brooms picking up the sweepings and transporting the same to disposal points on completion of the nights' work.

In the suburban districts the work is carried out by gangs of men varying in number from three to six, which gangs are supplied with a handcart to collect the sweepings, while the larger

collecting vehicle may be absent. These suburban streets are swept according to requirements, which vary from once to six times per week.

Between these two—i. e., the inner city streets and the outer suburban streets—the system can probably best be described as a combination of the two.

In addition to the night work previously mentioned, squads of men are out washing certain streets in the central areas—this operation being more extensive in character during the winter months than during the summer months.

The total quantity of materials swept up from the streets averages about 56,000 tons per annum.

Closely allied with this work is that of the emptying of the street gullies. Until last year this was done by hand operations, but my committee has recently commenced to carry out a portion of the work by means of a vacuum gully cleanser.

Band for Large Cast Iron Pipe

The practice in New York City of using bands and bolts to hold pipe from pulling apart where bends, offsets, tees, reducers or caps are used and there are no lugs on the bell or spigot end of the pipe and fittings was described by William W. Brush, chief engineer of water supply, Department of Water Supply, Gas and Electricity, of New York City, in a paper presented at the 1928 convention of the American Water Works Association. An abstract follows.

In special cases such as the high pressure installations of recent years an amalgam of tin and lead has been successfully employed, but usually the bolts and bands are installed. For a 90 deg. bend it is customary to tie together pipe that are 12 in. and larger in diameter. On each side of a 90 deg. bend normally three lengths of 12-in. pipe are rodded while for a 20-in. and larger pipe five lengths are rodded. Where other than a 90 deg. fitting is used the number of lengths to be rodded is determined by the construction engineer based upon pressures in the pipe and character of fitting as affecting the amount of unbalanced pressure to be taken up by the rods.

Both our experience and that of others indicates that in caulked lead joint the holding power for each square inch of lead in contact with the pipe is about 200 lb. When the unbalanced pressure produces a force to support the pipe greater than this holding power, the pipe moves in the joint. Under such conditions the joint must be held together by some other means.

In November, 1927, the department was compelled to raise a 48-in. cast iron main laid in Columbia street, Queens, due to the main interfering with a new sewer. It was decided to offset the main after reducing to 36-in. diameter on account of limited cover. When the pressure of about 80 lb. per sq. in. was applied to the band on the spigot end of one 48-in. pipe moved about ¼ in. and the offset raised in the center sufficiently to allow the lower rods to drop out of place. From this experience it was evident that the bands used would not hold unless stud bolts or similar stops were placed in the pipe or unless rods were carried back of the next bell. The latter plan was considered more advantageous and was adopted as standard for future construction where lugs were not available. With all bands anchored by a hub, movement of the bands by sliding is prevented and one can rely on the rods taking up the unbalanced pressure up to the full strength of the rod.

It has also been suggested that the band might be tapped and the pipe drilled so that stud bolts would extend into the cast iron far enough to give the necessary resistance to the movement of the band by the shearing strength of the bolts plus the frictional resistance of the band. There are a number of other methods that could be followed in securing the band against movement. The interesting fact is that dependence on bands that have been clamped tightly around the pipe and by the use of bolts is not sufficient when large unbalanced pressures are to be controlled, and from our experience additional resistance to movement of the bands is essential.

Filter Flints

There is shown in the accompanying illustration the close grading of six sizes of filter flints—(there are many more sizes than these) taken from a newly uncovered deposit in Southern Jersey. In smoothness and roundness, the grains resemble marbles of different diameters. It is claimed they will withstand abrasion and wear for a very long period of time because of the fact that each grain is a piece of pure flint.

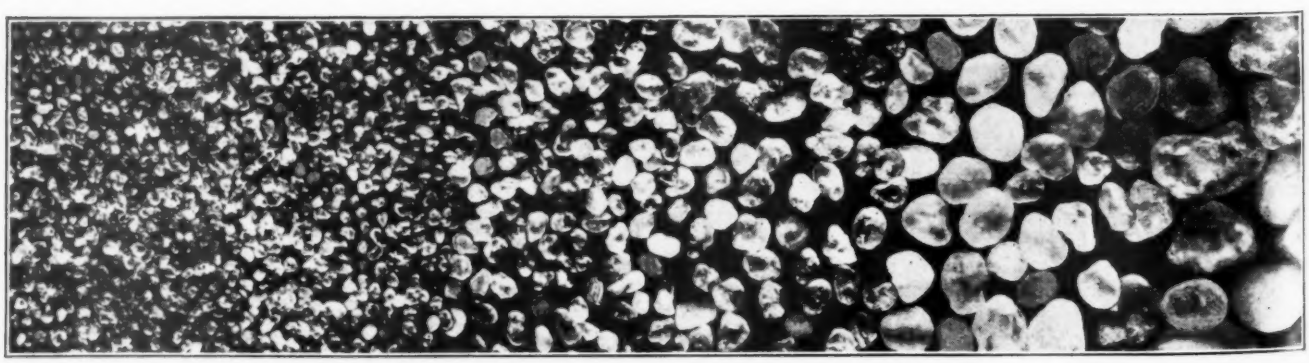
The illustration also serves to give a cross section idea of a filter bed in which these filter flints are used. Since all grains are of such uniformity in smoothness and roundness, each layer will present a series of larger openings between grains as the diameter of the grain increases. In other words, there will be uniformly large openings at the bottom layer and small at the top. The liquid being filtered will therefore percolate through the bed at an even rate of flow.

The flint hardness of the grains is claimed to guarantee practically no wear on each grain, meaning that the filtering opening between grains will remain constant and hence always give an unvarying rate of flow.

At the site of this deposit of filter flints, George F. Pettinos, 1206 Locust St., Philadelphia, has erected a plant for washing and classifying flints with great accuracy. The result is a grading for effective size and co-efficient of uniformity which, it is claimed, will meet the most exacting specifications for any class of service.

This plant itself is unique. There is nothing just like it in the country. In its method of exact sizing of many different diameters of flints at the same time, and washing each grain almost separately, this plant sets an example of efficiency which is much needed in this particular field.

While space at present will not permit a description of the plant, it is to be hoped that in an early issue we will be able to present photographs and a complete description of this new type of plant. Suffice to say that it has a capacity of 20 cars of filter flints per day, either wet or dry, washed and screened to meet any specification.



Six Gradings of Filter Flints Taken from Newly Uncovered Deposit in Southern New Jersey

Airports As a Factor in City Planning

Valuable Data on Layout Given in National Municipal Review Supplement

By E. P. GOODRICH
Consulting Engineer, New York

AIR transportation has become a recognized means of carriage of persons and property. A department of commerce report of July, 1927, records 864 operating air ports and airplane landing fields in the United States with about 3,000 additional unequipped emergency landing fields. Of the 864 fields, 207 are municipally provided, 163 are commercial or private ports, while 124 are department of commerce intermediate landing fields. Eighty-one landing fields are maintained by the Army and the Navy. The characteristics of air ports place them in the same general class with railroads and water carriers in that special terminal arrangement must be provided. Furthermore, air terminals are like railroad and water terminals from the fact that each must be located on favorable topography. Within certain limits, however, an air terminal does not need to be directly connected with the approach facilities. A railroad terminal must have main line tracks leading to it. A water terminal must have a water way to provide access. An air port makes use only of the air for accessibility and consequently is not so tied to topographic approach conditions. However, it must be so situated that the approach routes do not generally lead over cities, and for use by airplanes it should not be surrounded by high hills except at considerable distances with no high trees, chimneys, poles, or other structures in closer range. It is more than possible that the approach routes will some day be fully cleared so that air transport routes will traverse country so prepared that emergency airplane landings will be possible at any point along the route, instead of only at emergency fields located perhaps five miles apart. An air terminal must usually be placed in the open country. Like terminals of other varieties, however, they should be as close as possible to the business center of the community to be served.

Croydon is about ten miles from Trafalgar Square, London, Le Bourget is seven miles from the center of Paris, while Tempelhof is three miles from the heart of Berlin. The landing fields in New Jersey and on Long Island are so far from the hotels in Manhattan that lately it took as long to motor from one of them to New York as it had taken to fly from Boston. The Cleveland municipal field in nine and a half miles from the public square (air line distance),—about thirty minutes by auto and conceivably about twelve minutes by train. That it is undesirable to locate a field any considerable distance from the business center is indicated from the report that one European city abandoned an outlying air port and created one relatively close to the center by razing several blocks of buildings.

Ample Means of Access.—Like all other terminals, ample means of access must be provided for conveyances of other types between which and the air carrier transfer of passengers and property must be made. In the early days of the railroad and steamship, large crowds would gather for the arrival and departure of the carriers. In the early days of the automobile, auto race meets would draw large crowds of spectators for which provision had to be made. While air transportation is new, while air circuses are a novelty, and while the exceptional aeronaut is accomplishing unusual feats, extra facilities must be provided at air terminals for spectators, and highways, street railways and even steam railroad connections must be provided to transport the people. When Lindbergh landed at Le Bourget, the roads leading to it from Paris were congested with motors for miles. In other words, the highway approach accommodations were inadequate in that instance. Such thoroughfares should be provided from the field in as many directions as possible and sufficient in capacity to carry away all the automobiles of all the inhabitants of the surrounding territory for a radius of at least fifty miles within a period of perhaps three hours.

Road Space.—With one automobile for each family (there was one car for each five persons on January 1, 1928), and at a running capacity of perhaps 1,000 vehicles per lane per hour under proper policing, after assuming a factor to represent the probable percentage of vehicle owners who would wish to visit an aviation field on some special occasion, a basis is laid for a determination of the highway facilities which should be provided in a given case. (For example, assume that one quarter of Paris had desired to see Lindbergh land at Le Bourget with five persons on the average per automobile and assuming three hours as a legitimate period in which to clear the field, then the following computation gives the number of free lanes of travel which should be provided: 3,000,000÷4=750,000 persons who desired to visit the field; 750,000÷5=150,000 automobiles to be provided for; 150,000÷3=50,000 cars per hour to be handled; 50,000÷1,000=50 lanes of travel required.

Street Car Facilities.—Similar methods applied to the trolley transportation, using 100 persons per car and one car per minute would give the required equipment and number of tracks. (For example, assume that one half of the number in the last example had preferred to travel by trolley instead of motor: 750,000÷2=375,000 persons to be accommodated; 375,000÷3=125,000 per hour; 125,000÷100=1,250 cars loads of passengers per hour; 1,250÷60=21 single tracks required.)

Railroad Facilities.—With steam railroad transportation a ten-car train accommodating 1,000 persons per train can be dispatched every ten minutes. (As a further example assume that one third of the people desired to travel by train: 750,000÷3=250,000 persons to be accommodated; 250,000÷3=83,000 persons per hour; 83,000÷1,000=83 train loads per hour; 83÷6=14 tracks required.)

The problem of parking space for the motors and sidings for the storage of trolley and steam equipment is of importance. An automobile occupies 200 square feet on the average. One hundred per cent must be added for access. This gives 400 square feet per motor car. A trolley car requires 500 square feet, and a ten-car train 10,000 square feet. Something more must be added for switches and leads, loading spaces and safety areas. In each case the figure should be approximately doubled. (In the examples above, had one third of the visitors traveled by each of the three modes, the following parking, standing and loading areas would be required: 750,000÷3=250,000 persons by each type of travel; 250,000÷5=50,000 motors to be parked; 50,000×400=20,000,000 square feet=460 acres of parking space required; 250,000÷100=2,500 trolley cars required; 2,500×1,000=2,500,000 square feet=58 acres of trolley waiting and loading space needed; 250,000÷1,000=250 trains necessitated; 250×20,000=5,000,000 square feet=116 acres of steam railroad siding and loading space demanded.) Of course, motor buses

may replace trolleys in many instances and much express and freight will move by motor truck. In exceptional cases, mail tubes may connect a landing field directly with the post office at the business center of the community.

Existing Highways. — Incidentally, while transportation accessibility is of great moment in locating an airport, its creation should be such as to hamper transportation as little as possible to points beyond it. The area required for a large flying field will generally overlap one or more major thoroughfares which would consequently have to be closed. Such closings should be obviated if possible. It is sometimes possible to select a site which is adequate for immediate needs and which can be enlarged progressively by being used as the community refuse disposal site. It is hardly to be expected that regular traffic will ever reach such figures as are now being attained while aviation is a novelty. Plans adequate for the present may, therefore, be expected to be ample for the future.

Emergency Fields.—Pending the future era when a continuous cleared airplane landing strip is provided, numerous emergency landing fields should be arranged, especially in fairly well settled territory like the suburbs of cities. Each of these should have an area of about ten acres and be as strategically located as possible. They should be located at most not over five miles apart, and around cities should be spaced throughout the whole area, at the corners of five-mile squares, or approximately so.

In addition to air ports, standard practice locates intermediate landing fields at intervals of about thirty miles. These should have an area of approximately forty acres and be designed as nearly square in shape as is possible. Their placement demands almost as

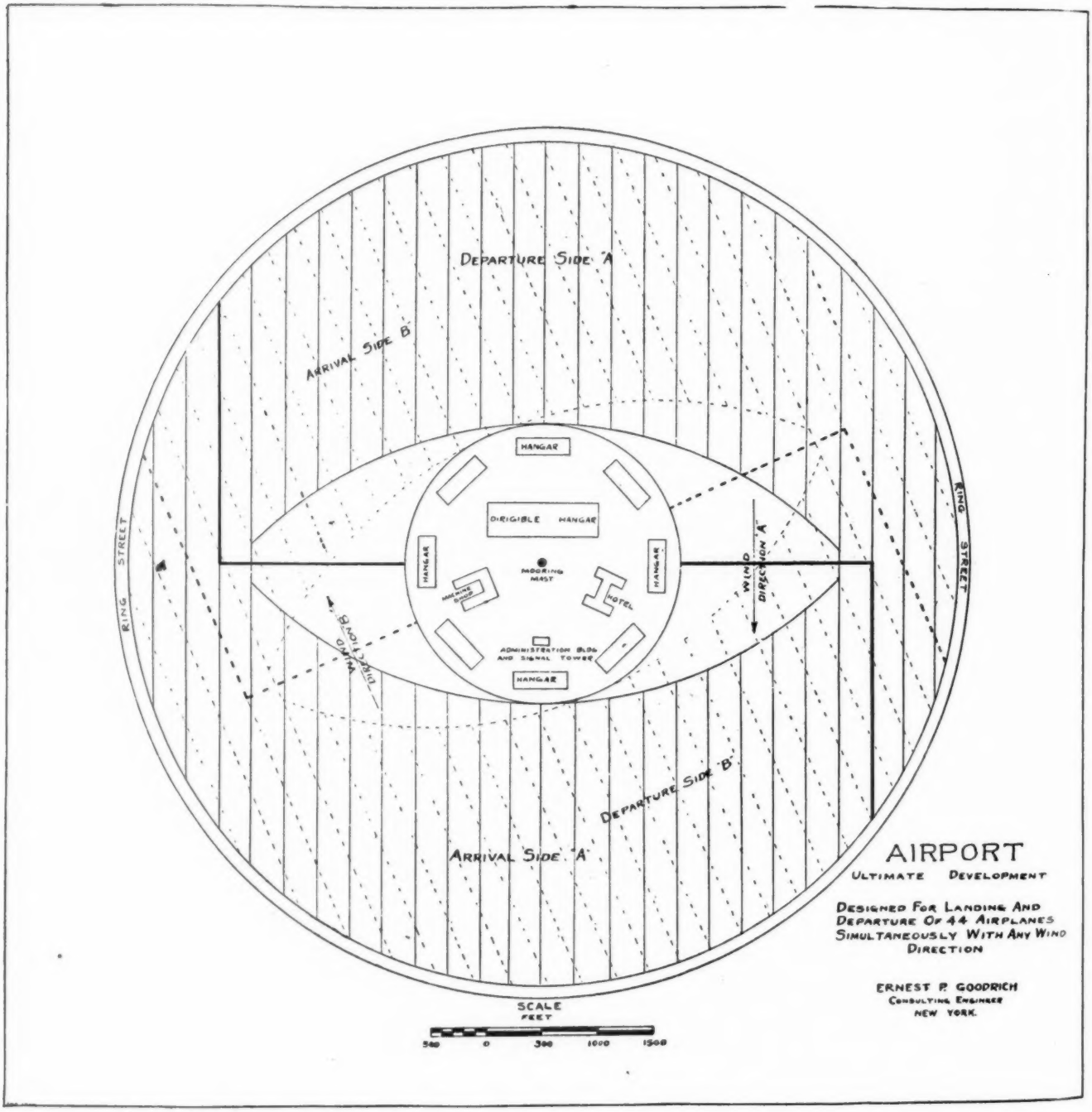


Diagram 1.—The parallel solid lines divide the field into 22 departure lanes and 22 arrival lanes, corresponding to wind direction A. Each of these lanes is 300 ft. wide and 2,500 ft. long. The dotted lines show the lanes which would be used for wind direction B. Note that the mooring mast, shops, hangars and other buildings are located around the center of the field, at the point of maximum convenience, but do not in any way obstruct the runways. The area of this field is approximately 1,000 acres

much study with reference to the city plan as is needed with reference to the larger air ports. Since they are for emergency use only, they may be cultivated with any crop which does not grow high.

Area Requirements.—The areas required for airplane landing purposes should be clearly differentiated from the area required for the handling and mooring of dirigibles and for the several necesary adjuncts. The department of commerce has tentatively determined the area necessary and advantageous and has proposed a classification of airplane landing fields dependent upon the various facilities available. Fields now actively in use vary all the way from 1,000 acres (Mitchell Field) and 700 acres (Cleveland) down to 40 (Boston and Pittsburg), with 25 acres considered the smallest reasonable size for landing except in cases of emergency. Much talke has been heard about roof landing areas, but until new and special designs of planes are common, roofs will not come into general use. Even then, because flying over cities involves extra hazards for both plane and city, roofs are not likely to come into very extensive use for landing purposes.

In rising, an airplane must head into the wind, attain a speed varying from forty to eighty miles an hour on the ground before rising may be attempted. The lighter machines attain this speed rapidly and can, under favorable conditions, leave the ground in from 400 to 800 feet. The heavier planes, those used for freight, mail and passengers, require, under favorable conditions, a distance of from one to two thousand feet before leaving the ground. In addition to the space required on the ground, it frequently happens that the motor stalls immediately after rising, necessitating landing at once. To provide for this emergency, another thou-

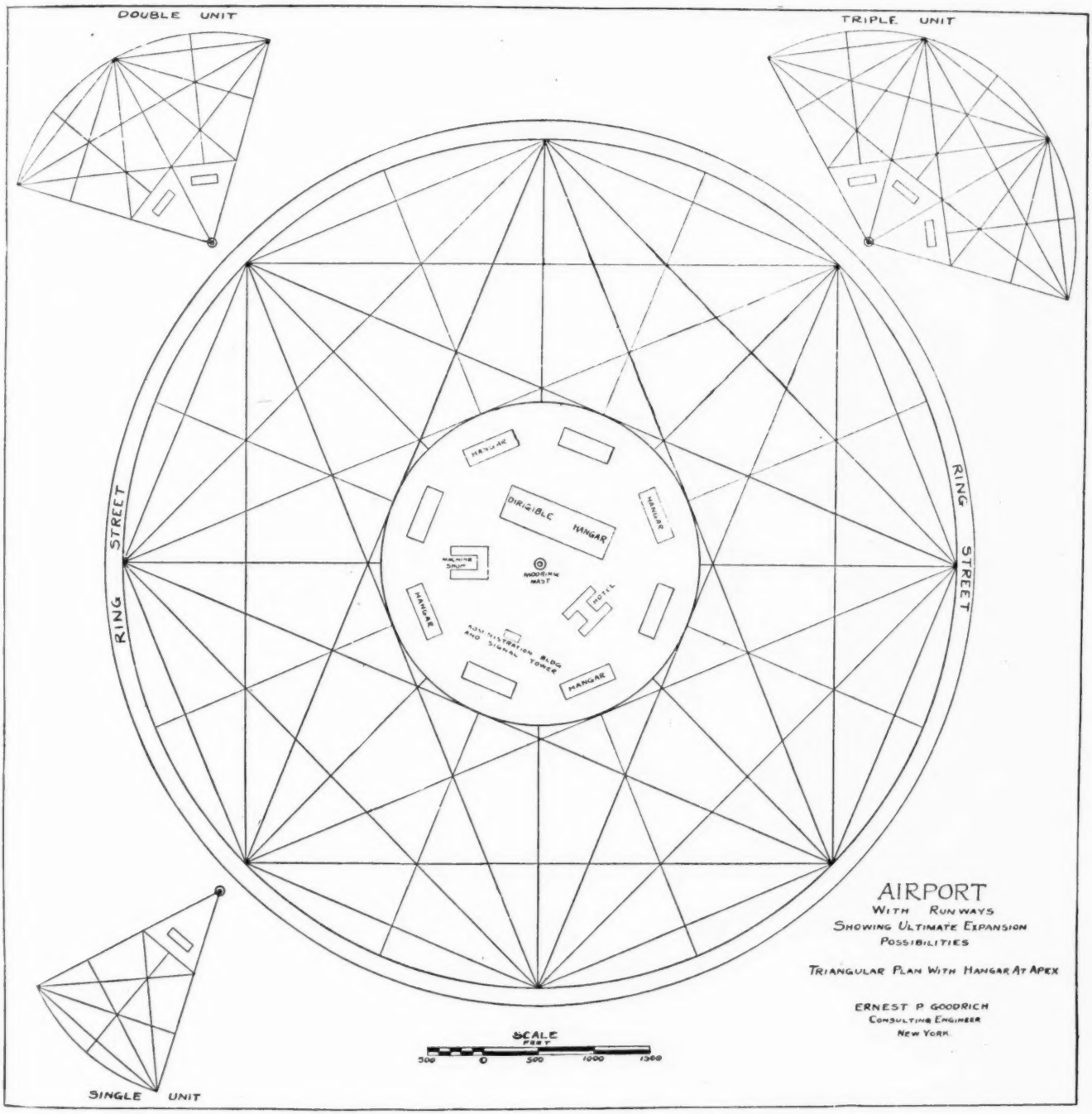


Diagram 2.—Here is an airport that may be started as a small unit and then expanded later as needed. The first unit is shown in the lower left hand corner, calling for an area of 125 acres, with mooring mast and hangars at the apex, and with 8 runways, each 2,500 ft. long, paved or otherwise prepared as required. These runways provide for eight wind directions varying about 45 deg. Succeeding units are easily added as shown, with the complete field of eight such units shown in the center

sand feet is necessary. A total, therefore, of from 2,700 to 3,000 feet is the minimum length of runway, to accommodate all of the now existing types of planes. In rising or in landing, an airplane makes an angle of approximately eight degrees with the horizontal, or for each foot of rise it moves forward seven feet. If there should be a one-hundred-foot building at the edge of the field, it would render seven hundred feet of the field useless. The minimum distance mentioned (2,700 to 3,000 feet) for a runway must, therefore, be increased by seven times the height of any buildings on the edge of the field.[1]

Giant Planes.—Several giant planes now under construction are reported to have wing spreads up to 140 ft. This dimension together with an equal side clearance determines the required width of runway. The projected Junkers model J-1000 is to have a wing spread of 220 ft. Detailed specifications for the classification of air ports have been issued by the department of commerce under date of March 13, 1927.

The requirements for air ports for the use of the future mammoth dirigibles, 150 ft. in diameter and 750 ft. long, have not been as definitely determined. Two such ships moored to towers (with their lofty departure platforms) with space to swing with the change of wind direction would require an area 1,500 ft, by 3,000 ft. a border at least 1,000 ft. wide entirely around the field and additional area for hangars. The latter must be much larger and differ otherwise from airplane hangars.

While most cities are making efforts to provide one large field as near as possible to the business center, it seems better economics in many instances to provide one or more fields suitable for loading and landing passengers, mail and express, fairly close to the center,

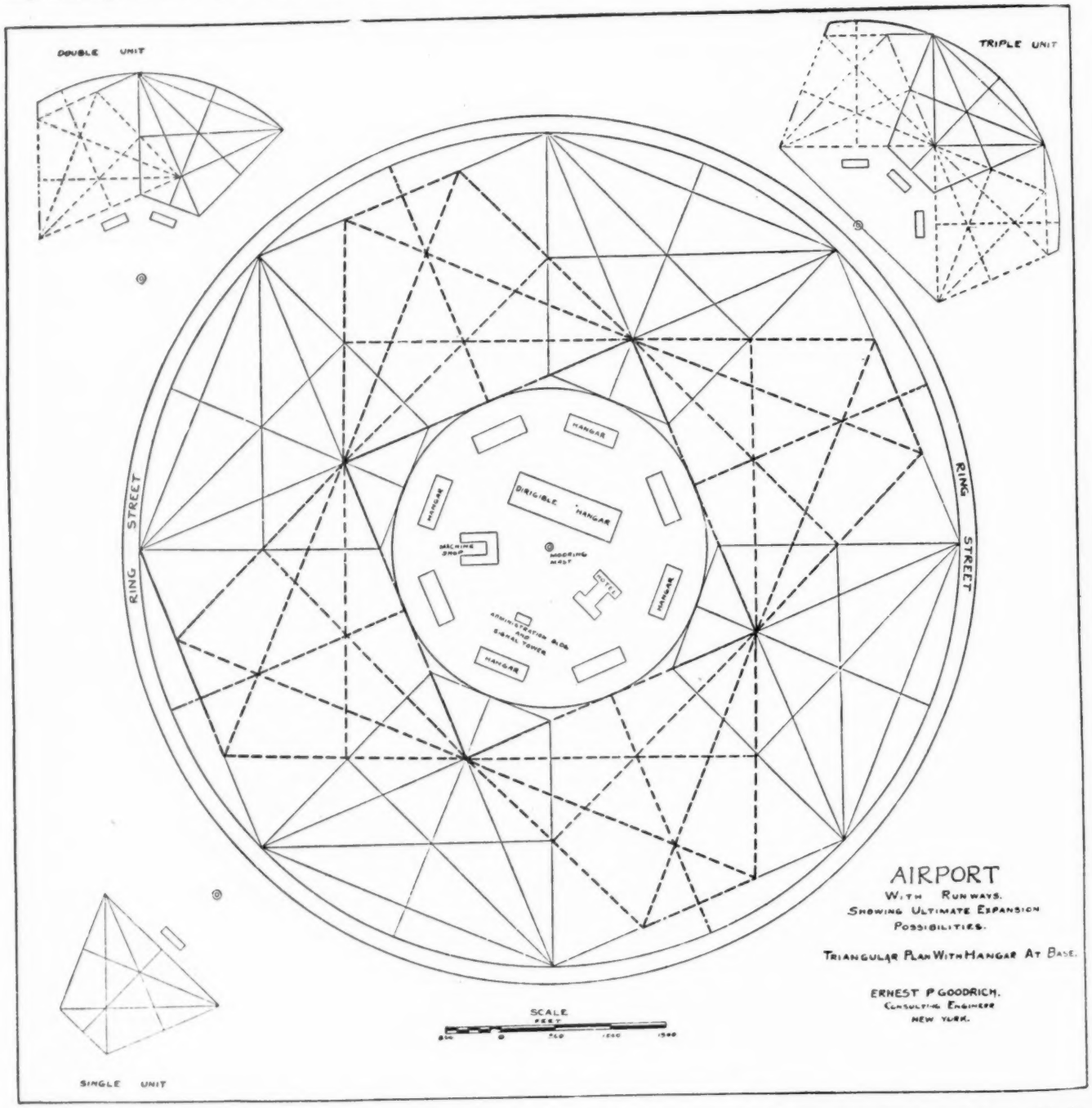


Diagram 3.—The principle of building up the complete airport gradually, by adding units, from time to time, may also be carried out with the hangars at the bases of the units as shown in the above illustration. The finished airport will comprise four such units, shown by dotted lines, and spaced between these will be four other units (shown in solid lines) similar to those in Diagram 2. These two types of units will overlap. The double unit developed in this way is somewhat more flexible as concerns the layout of runways than is the double unit of Diagram 2

with a service field at a more remote and less expensive site.

Factors Influencing Area Needed.—The area required for a field will obviously depend largely upon the amount of use to which it will be put. If ten planes arrive and depart each day, a single runway would be sufficient for use by all. If, however, ten planes are to arrive and depart each hour, it may be necesary to use different parts of the field for arrival and departure respectively and to control the arrivals and departures by a signal system operated by a despatcher as is done at Tempelhof (Berlin). The loading and unloading accommodations could then be placed advantageously at the center of a large field, arrivals approaching this center from one direction (against the wind) and departures taking place on the opposite side of the loading and control station (again into the wind). Since the wind may blow from any direction, the central depot would have to be reached on the surface solely by automobile,—the cars approaching in the same direction as the arrival of the airplanes, from a ring drive which entirely encircles the field and outward from which the thoroughfares and transportation lines would extend. In the case of an extensive, intensively used air port, the automobile and other transit lines might advantageously be brought to the central depot under the surface of the field. While expert pilots will doubtles learn to take off irespective of wind direction (as some do even now in light breezes), there will always be so many who will desire to head into the wind while landing and taking off that it will probably never be possible to ignore the effect of wind in locating and laying out a flying field.

Future Planes.—The area required for the air port of the future will depend in a considerable measure upon the development of the air carrier. Several alternatives seem possible: (a) A machine which can ascend vertically or nearly so, by means of (1) the helicopter principle or some related idea, or (2) a new wing design or arrangement, or (3) both combined; and (b) a machine which will fold its wings after it alights, thereby greatly reducing needed storage space and possibly also being able to traverse existing or special new highways. At Teterboro, not long ago, Chamberlain demonstrated a small plane which kept an even keel when flying at only fifteen miles per hour and required only 60 and 75 ft. of roll respectively to take off and to land. (Most existing planes will stall and drop into a fatal tail spin at a speed of about fifteen miles or less.)

Special Devices.—Devices are sure to be developed to assist in taking off and landing. The compressed air catapult employed for the launching of naval planes, and the decelerating cables which drag bags of sand on the decks of airplane tenders are present-day examples. Perhaps the simplest scheme is to form the surface of the landing field like a flat dome with the depot at the center of the top,—approaching planes landing up the incline and being assisted in stopping by the force of gravity, while departing carriers would leave by sliding down a slope with the assistance of gravity as Lindbergh did (as described in "We"), as Byrd did on his start to the North Pole, and as many others have done from time to time. It is reported that one of the British army air fields used during the war was located on a rounded hill (similar to the scheme here proposed) and that the opinion of the pilots was altogether favorable. Incidentally, the interior of the dome could be used for hangars, for means of access, and for parking of autos, trolleys and other means of land conveyance.

Selection of Site.—From a topographic standpoint, it is now generally felt desirable to secure large level areas for landing fields. (A two per cent grade is considered the maximum.) So as to reduce approach hazards to a minimum, these fields should be chosen as far as possible on hilltops or high ground. This generally reduces ground haze compared with valley sites and the obstructions surrounding the field are not as high as in the case when hills surround the port. Islands, especially artificial ones, if of sufficient size generally possess advantages as to levelness, freedom from approach obstructions, and complete liberty in direction of approach. Accessibility is generally unsatisfactory, however, and they are more apt to be affected by fog. Wherever sea planes can be employed on a route in any direction from a port while land machines operate over other routes, a combined water and land port is considered desirable. However, certain disadvantages inhere in having water ways or water areas as bordering features of a land port because of the incidental hazards to land machines. Larger fields are required under such circumstances. It is believed by many that most planes will eventually be designed so as to alight either on land or water. Obviously, in choosing a site the necessary costs involved in leveling hummocks, doing under-draining, filling ditches, ruts, and sunken roads must be considered, but such work is essential to a successful field. The soil must also be such as to produce a thick tenacious sod and where a practically square or round field cannot be obtained because of topographic difficulty, the greatest length of the area available should extend in the direction of the prevailing winds. In addition to available transportation, electric light and power, water and sewerage must be available or obtainable. Where a sod is unobtainable, concrete, asphalt, macadam or cinder surfaces must be provided. It is generally conceded that when an airplane lands it strikes the ground with a blow equal to perhaps five times its dead weight. Consequently, the surface must be very compact. A dusty field is very objectionable, also.

Length Formula.—At sea level the length of the field at least in the direction of the prevailing winds should, as has been said, be not less than 2,500 ft. plus 7 ft. horizontal space for each foot of height of obstructions at and beyond the boundaries of the field at each end. Greater dimensions are considered desirable if they are obtainable. For altitudes above sea level, longer runways are required. An approximate formula for the necessary length of runway for such an air port is as follows:

$$\frac{10}{3}\cdot\frac{A}{C+10{,}000}=\log_{10}\frac{15R}{r}-15\ .$$

In this formula

A is the altitude of the air port above sea level,

C is the A.B.S. ceiling of any plane, for which

r is the take-off length of run on a level field at sea level, and

R is the necessary length of runway at altitude A.

The ratio $\frac{1}{7}\cdot\frac{R}{r}$ is the angle of clearance of all obstructions which must be maintained beyond the runway. The field arrangement and that of the several accessories, — signals, lighting, hangars, shops, waiting rooms for passengers, pilots and workers, field markings, beacons, foggy weather signals, wind indicators, oil and fuel tanks, radio landing control aids and other items,—is not of moment from a city planning standpoint, and the requirements for each of these matters can be found in department of commerce bulletins and technical publications. The lengths required for taking off by sea planes are longer than for land machines and the water areas should be correspondingly larger. To take off, large sea planes require as much as 3,500 ft. clear run unobstructed by such things as bridges, breakwaters, or buoys, with a very flat angle of clearance beyond this take-off stretch. They also require at least six feet of water depth. N. A. C. A. Report No. 249 shows the take-off and landing speeds of nine different makes of plane. They range from 48 to 63 miles per hour at take-off and from 44 to 58 at moment of landing.

A practically smooth surface is thus seen to be necessary. Normally this can be secured by some expenditure, but obviously the site should be selected with this point in mind. The same reports gives the take-off and landing rolling distances, which range from 275 to 505 ft. for taking off and from 200 to 950 ft. for alighting. Unless the surfacing of air ports is such as to minimize the dust, it has been shown that even inside hangars the

[1]Quoted from National Municipal Review, February, 1926, p. 106.

dust will often be so great as to affect the bearings detrimentally. Therefore, the hangars should be placed at the side of the field at right angles to the prevailing winds. With a large field in which the hangars are to be at the center, it is thus seen to be advantageous to have the parked airplanes housed below the surface as would be the case in connection with the dome shaped field elsewhere suggested.

Number and Distribution.—It seems reasonable to expect that eventually air ports will be distributed and be of capacities comparable with those characteristics with existing railroad terminals in the relation of the latter to local population groups. In other words, air ports will be proportional to the population served. Commander Byrd is quoted as saying that "aeroplanes will never be used for popular flying as the automobile is used for traveling." The limiting factor in the development of air carriage will probably be the number of available pilots. Students of the problem suggest that not over 10 per cent of the population possesses the natural capacity to guide safely a vehicle which can move in three dimensions. The licensing of automobile drivers shows that not all persons are capable of operating in two dimensions. Assuming a population of 200,000,000 with 10 per cent capable of operating aeroplanes, there would be a maximum of 20,000,000 possible planes moving around the country simultaneously. Incidentally, the average mileage per year of the present-day motor car is around 600, whereas it would be 60,000 were all cars to be operated at 20 miles per hour for 10 hours per day for 300 days per year. The average automobile is thus seen to be moving only 1 per cent of the time (day time). Or, in another point of view, 1 per cent of all automobiles are moving at all times. They stop and start at least once every day. In fact, the average trip is probably less than two miles, so that there are 20 stops and 20 starts each day for that 1 per cent.

As a first approximation, the same ratios may be applied to air carriers. Of the 20,000,000 possible pilots, 100,000 may be expected to be on the move at all times. With 40 landings and take-offs per day there would be 8,000,000 per day. Assume one every ten minutes for 13 hours, or 80 per day. That indicates 100,000 landings or departures each 10 minutes throughout the country. While landings can obviously be made at shorter intervals than 10 minutes, the time required for the loading and unloading of passengers and freight, the manoeuvering from point of arrival to point of departure, and the signalling to other planes arriving and departing will normally demand approximately 10 minutes as the arrival and departure interval on any given runway.

Population Ratio.—These conditions are strictly comparable with those which hold in connection with passenger and freight railroad terminals. With 200,000,000 population, a landing field or runway is indicated for each 2,000 population. If a factor is introduced to care for a probability concerning air craft like the fact which exists with reference to automobiles, that there are at least 25 per cent less automobile licenses than actual persons capable of driving them, then the figure 2,000 should be increased to 2,500. If only small planes are to be accommodated, this figure can be multiplied by four. For the smallest present type of plane, such as the one in which Chamberlain lately took off from a city street, this figure can be multiplied by 15. Chicago in 1927 had 15 landing fields—seven municipal, six commercial, one army and one postal; Los Angeles had eight, seven being commercial. By states, California had 100 fields, Texas 84, Illinois 64, Ohio 50, Oklahoma 40, New York 30, Arizona 29, Colorado 22, Iowa 24. Obviously the figure of 2,000 persons per landing field does not apply to the present. There are not yet 200,000,000 persons in the United States and there are only about 4,000 licensed pilots in the country, with 2,111 planes listed in the 1927 Aircraft Year Book. With New York's prospective 10,000,000 people, 5,000 such landing spaces would have to be provided. Obviously they should be well distributed so as to minimize air traffic accidents, and a signalling system will have to be employed so that planes can land and take off simultaneously, each on its own 300 by 2,500 ft. runway. A circular field with a diameter of 7,500 ft. would provide for the simultaneous handling of 44 planes with any direction of the wind. Obviously possibilties exist of reducing the assumed ten-minute landing interval, and of securing a greater use of such a field when a type of plane shall have been developed which will require a shorter runway. In other words, an air port of that size and design would afford the facilities needed by a population of from 220,000 to 450,000, according to whether present-day dimensions or future probable ones are assumed. Using the larger figure, it is seen that New York City should plan to provide thirty-five square miles of landing fields to meet its future requirements. The landing fields in the vicinity of New York City for which the department of commerce had issued aeronautical bulletins up to January 1, 1928, aggregated just over four square miles.

Future Development.—As to air transportation we are back in the days of the first railroads when cities and citizens fought verbal battles over the location of the railroad station. The lesson to be learned from the figures is that ample open spaces available for eventual air fields should be acquired and set aside in each community. Until they are required for aeronautics they can be employed as recreation space, either active or passive,—athletic fields, wild life preserves, and formal parks. When they are needed for air use, the radius of travel of the average man by motor, rapid transit, or air will make them relatively unnecessary as open spaces. Meantime, if invention eventually eliminates the necessity of such long landing and take-off runways, then the open spaces acquired will continue to serve a legitimate purpose to the benefit of the community.

Special purpose flying fields will be developed and must be considered in regional, if not in city planning. Flying schools must have their fields (in 1925 there were twenty-two such schools); special seaside landing areas will be required to serve the planes which bring ashore transatlantic mails and "rush" passengers; special landing fields along mail routes will be created where a mail plane can drop a mail bag and pick up another either without stopping or merely taxying along the ground and taking off without longer pause; a few down-town landing spaces on the tops of buildings will be developed similar in equipment to the airplane tenders in the Navy; special fields will be made available adjacent to large hospitals where ambulance planes can land; of course, the Army and the Navy will require special fields; and other special uses will develop. The parking near a city of planes owned by flying commuters will be another special problem. Aside from the landing runways required, a hundred such planes would require nearly five acres of parking space. Because sea planes are somewhat larger than the average, one hundred such would require approximately seven acres.

Fogs.—Perhaps inventive genius may some day learn how to dissipate or control fogs, or at least develop neon or other light signals, electric capacity-height indicators, radio direction guides and other aids so that landings can be made in spite of this, at present, dangerous meteorological handicap. Meantime, that site should be selected which is shown to be naturally freest of foggy weather and ground haze. Factory smoke may be as detrimental as ground haze and a field should not have a large industrial district to the windward. Locations exposed to frequent gusty winds are to be avoided, and special measures must be taken when excessively heavy rainfalls are to be expected. Because of the annoyance arising from the noise and flashing lights unavoidable at an airport, the location should not involve a residential district.

As to expense, the Department of Commerce states that current projects may be found to involve a cost of about $100 per capita. Small fields may cost as little as $50,000, while Chicago now proposes an expenditure of $2,000,000.

Algae Control in Uncovered Distribution Reservoir By Chlorinating

Results Obtained and Simple Method of Applying Treatment

By L. B. MANGUN

Chemist in Charge, Department of Water, Light and Power, Kansas City, Kan.

THIS reservoir is part of the distribution system of Kansas City, Kan. It has a capacity of 13,000,000 gal. and is situated about six miles from, and at an elevation of 217 ft. above, the pumping station. It is connected to the city distribution system by a 24-in. main, through which the water both enters and leaves the reservoir. The reservoir is circular in shape with a diameter of 400 ft., giving a surface area of 125,000 sq. ft. of water varying at different times from 4 to 13 ft. in depth, averaging about 8 ft. in summer. It is intended to afford not only a reserve supply but semi-automatically to equalize the pumping rate throughout each 24 hours, as well as between weekdays and holidays. Under normal summer conditions 2,000,000 or 3,000,000 gal. are used out during the daytime and 1,000,000 to 2,000,000 gal. restored during the night. Consequently, beginning with the reservoir almost full on Monday morning, there is ordinarily a more or less steady loss during the week, so that it usually contains less than 5,000,000 gal. on Saturday evening. Over the week-end it is attempted to have the reservoir as full as possible again by Monday morning.

Under these conditions the reservoir is constantly supplied with cool water, rich in diatom food, and with turbidity, color, depth and period of storage all very favorable to algae growth. The season requiring measures for algae control is of about five months' duration, from May to September, inclusive. The growth is most luxuriant during periods of high temperature and bright sunshine, and the heliotropic action of the diatoms, in conjunction with the liberation of oxygen during growth, gives them the buoyancy which keeps them in constant suspension. This algae laden water, at times highly impregnated with tastes and odors, formerly was the cause of much complaint in sections of the city which were reached by water from the reservoir.

Treatment With Blue Vitriol.—The method of Moore and Kellerman for algae control by blue vitriol treatment has given fairly satisfactory results under the conditions obtaining in large impounding reservoirs, especially with waters of low alkalinity, but meagre success has attended its use in reservoirs of other types. Until recently little attention seems to have been given to methods of control in distribution reservoirs of the kind described above. It has been the common practice to empty out the water whenever absolutely necessary, clean, and perhaps spray the floor and walls with blue vitriol solution. By these and similar palliative measures the nuisance was endured until it was ended by covering the reservoir. Thus the problem of algae control in open distribution reservoirs was solved by doing away with the problem itself.

Conditions in distribution reservoirs differ so greatly from those in impounding reservoirs that the same satisfactory results of copper treatment cannot be realized. In the latter a long reaction period is available, only parts near or distant from the point of withdrawal may be treated, and withdrawal may be changed to different depths. In distribution reservoirs there is little possibility of preventing the freshly treated water from entering the mains, the reaction period is short, and though there is a constant change of water, it is not rapid enough to prevent cumulative plankton growth.

Results of Blue Vitriol Treatment.—Nevertheless, prior to last year blue vitriol was frequently used in this reservoir. Saturday evenings were selected as the time of treatment, because the water was low and a given amount of chemical would give the highest concentration, and also because no water would leave the reservoir until Monday morning, 36 hours later, by which time the effects of precipitation and dilution greatly reduce the concentration. Tetrastrum was reduced in number but not destroyed under these conditions by dosages as high as 10 p.p.m. The maximum dosage suggested by Whipple for eradicating the hardiest diatom species is one part per million, and this figure, properly weighted according to the temperature, organic content and alkalinity of this water, is increased to 1.5 p.p.m. However, in the instance of our most drastic treatment, 10 p.p.m. was administered to this reservoir Saturday, July 3, 1926, when 6,000 Tetrastrum per c.c. were present. Twelve hours later it was reduced by dilution to 6 p.p.m., 24 hours later the concentration was 4 p.p.m., 48 hours, 2.2 parts, and Tuesday morning, 60 hours after treatment, when the water first went to consumers, 1.2 parts. At this time there were about one-tenth as many living organisms as before treatment which would be the number that dilution alone would give reason to expect. This dosage appeared only sufficient under these conditions to prevent further growth of these diatoms for two days, but not to destroy them.

The limitations upon the use of blue vitriol in any case are such that it should be considered as a permanent remedy or one that can be continuously used, and since in such a reservoir the necessity for treatment is so frequent it would be impracticable to attempt to keep the water in good condition by this means at all times, even if far more satisfactory results could be obtained from it than is indicated in the instance cited above.

Following the experiments in 1926, reported by Cohen, with algae control by chlorination in two small reservoirs in Texas it was concluded to make trial of the method in this reservoir. The immediate problem in this instance was to find a means of chlorinating the contents of the reservoir, which might at any given time be from 4,000,000 to 13,000,000 gal. of water. The blue vitriol had been applied from a boat, and it was possible to use a floating chlorinating outfit also, as provided by manufacturers for sterilizing small lakes or the larger out-door swimming pools. But the obvious awkwardness of that method in such a reservoir caused a search to be made for something more simple.

Method of Applying Chlorine.—The single 24-in. main which connects the reservoir with the pumping plant and distribution system terminates in a well, situated within the reservoir near the wall. This well has three sluice gates, one of which is at the bottom, facing the center of the reservoir. The second, a few feet higher, faces to the right, and the third, the highest, faces to the left. A test showed that the discharge of water to the right from the second sluice gate throughout the night would gradually set up a rotation of the entire body of water in the reservoir such that by morning, when the inflow ceased and outflow began, the water in the reservoir was moving at a rate of 20 ft. per minute, or nearly one complete revolution per hour. A Wallace and Tiernan vacuum type chlorinator had been connected with this main just outside the reservoir for the purpose of treating the out-going water because

of high bacteria counts following copper treatment, and also for the purpose of destroying as much taste and odor as possible. It was concluded to use this installation for the purpose of treating the reservoir, by allowing the inflowing water to carry the chlorine solution, and to obtain mixing setting up the rotation in the reservoir in the manner above described. Whenever it was desired to chlorinate the reservoir contents, which was done rather regularly about three times a week from July to September during the summer of 1927, the chlorine was fed into the main to the in-coming water during the night, beginning about 8 p. m., and at such a rate as would give the total volume in the reservoir the previously calculated dosage by 6 o'clock the following morning. The concentration of chlorine in the in-flowing water was ignored, although at times it was undoubtedly as high as 20 p.p.m., and would average 5 p.p.m. In other words, the reservoir water and not the in-coming water was being treated. The latter functioned merely as a minor flow for the purpose of treating a larger volume, the sole aim being the application of chlorine sufficient to show a residual in the entire reservoir within ten hours.

Results of Chlorination.—A representative treatment was as follows: A dosage of 1 p.p.m. showed a residual of 0.2 p.p.m. by 6 a. m. at the periphery of the reservoir, and 0.02 p.p.m. at the center. While this indicates considerable lack of uniformity in chlorine concentration at a given time, there is reason to believe that all of the water had received nearly equal treatment, for by 9 a. m., and even earlier on a sunny morning, all traces of residual disappear. Of course the discharge of free chlorine is hastened by photochemical action, but the appearance of the higher residuals is undoubtedly reduced by further diffusion and mixing. Such rapid dissipation of the chlorine indicates the possibility of considerably augmenting the dosage in case of necessity, or even this dosage could probably be reduced if some means of prolonging contact were employed, such as feeding lime or ammonia with the chlorine.

At the time of the first application of chlorine the reservoir water contained 13,000 synedra per c.c., and the suddenness of their disappearance following it was almost magical. At no subsequent time have any organisms appeared which have failed to yield to the treatment, and no objectionable after-effects have been observed. During the entire remainder of the summer not one complaint concerning the water was received from the section of the city served by the reservoir, a new and gratifying experience, indeed, as compared with any other corresponding season since the reservoir was built.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1928 convention of the American Water Works Association.

The Municipal Radio Station of New York City

The City of New York has for some time been operating a municipal radio station. Some interesting information on the operation of this station is given in "Reporting Municipal Government," a pamphlet issued recently by the Municipal Administration Service. The information, which is based on a memorandum from New York City department of plants and structures, follows:

WNYC, the municipal radio station of New York City, operates on a frequency of 570 kilocycles by authority of the Federal Radio Commission. The station is under the jurisdiction of the department of plants and structures.

From Oct. 1, 1926, to Sept. 31, 1927, 1,689 hours and 34 minutes were employed by WNYC in broadcasting programs. Of this time, 474 hours were given to instrumental selections, 296 hours to vocal music, and 920 hours were devoted to informational and educational purposes. Three hundred and twenty balanced programs were presented.

An itemized statement of the use of the station is as follows:

Citizenship.—The department of education co-operated with the station in securing well informed speakers upon municipal problems and related subjects. A series of eighty lectures was arranged in a course, each speaker being allotted fifteen minutes. Men prominent in civic and industrial circles spoke upon topics covering a wide range of thought. Addresses by leading lawyers were broadcast from the headquarters of the bar association.

Education.—A series of 384 lectures was presented upon educational subjects. By an arrangement between Commissioner Goldman and President F. B. Robinson of the College of the City of New York, the station was utilized by the municipal college as the agency to broadcast educational talks by the faculty of the institution.

Language Instruction. — During the year 208 hours were employed in language instruction. One hour per week was devoted to German, French, Italian and Spanish.

Fire and Police Control.—To an increasing degree the radio is being used by the police department for crime prevention and detection, and by the fire department for fire prevention. The present plan, when fully executed, will result in the installation of a radio set in every police station, police booth and river craft. A description of a robber is placed on the air and in five minutes 7,000 policemen have the warning through 250 stations. Radio reduces a multitude of telephone calls to one general call. Last year 21,239 persons were announced missing in New York City. A description of missing persons is broadcast every evening.

The city's station is utilized to inform people in the work of safeguarding life and property against fire. Fire prevention has been the theme of frequent talks.

Weather and Food Reports.—In co-operation with the departments of agriculture of the national and state departments, WNYC sent out reports concerning the condition of the market in relation to prices and supply of food. These reports were read at stated intervals during the week. Every evening a weather forecast was broadcast for the service of firms handling perishable goods, heating companies, electric light and power plants, orchardists outside the city, and travelers. The value of the service is indicated by the fact that New York annually handles perishable produce in excess of $1,000,000,000 value.

Music.—During the year fifty-seven band and orchestra concerts at Prospect Park and Central Park were broadcast. On Wednesday evening of each week from 8:30 to 10:00 the Adolph Lewisohn course in appreciation of music was broadcast from Hunter College. On each Wednesday morning the organ recital at St. John's Evangelist Church was featured.

Receptions.—Distinguished visitors to New York were received at the city hall from which receptions were broadcast. WNYC participated in the receptions to Colonel Lindbergh, Commander Byrd, Queen Marie, and Senator Marconi.

Cost of Park and Recreational Activities at St. Louis, Mo.

In his annual report, issued recently, Fred W. Pape, Park Commissioner of St. Louis, Mo., gave the following figures on the recreational activities under the directions of the Department of Parks and Recreation: The estimated attendance at baseball games during the past year was 1,975,000, while this form of athletics cost the city only $5,345 to maintain. The estimated cost per person was .0027 ct. Soccer football, it is estimated, drew 1,110,000 spectators. The maintainance cost was $1,985 or .0018 ct. per person. Golf cost the city $33,811, and there were 136,400 games played. Annual permits issued aggregated 593. There were 67,616 nine-hole permits and 29,145 18-hole permits issued. The cost was about 25 ct. a game. The maintainance of the tennis courts cost $12,251, and the number of games played were 206,875. There were 9,081 permits issued and the cost a game 5 ct. The report states 126,310 persons attended the 44 public concerts held. The salaries of the musicians aggregated $9,911. The total maintenance of the city's playgrounds cost $93,939, and the attendance of children during last season was 2,077,591. The attendance at public baths and swimming pools was 1,389,130, and the maintenance cost $78,208. The total expenditures of the Department of Parks and Recreation were $973,082.

The World's Largest Public Aquarium

Construction Now Under Way on Chicago's $3,000,000 Project

CONSTRUCTION work on the John G. Shedd Aquarium is now under way, and with its completion Chicago will have added to her institutions a public aquarium which will be the largest and most completely equipped in the world.

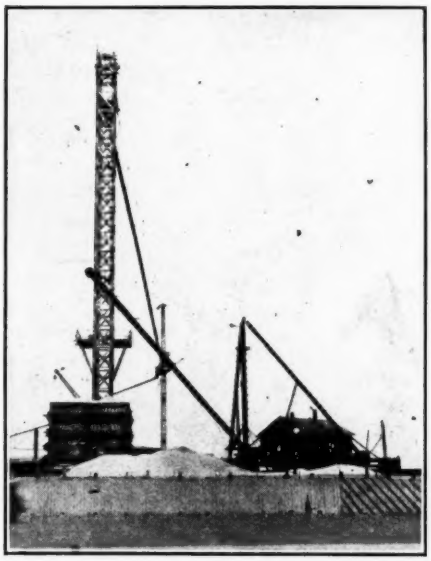
The new aquarium, made possible by a $3,000,000 gift by the late John G. Shedd for the purpose, will be located at the south end of Grant Park in the center of a newly-formed "round point," jutting into and partly surrounded by the waters of Lake Michigan and about 400 ft. northeast of the Field Museum of Natural History. Thus located close to the lake, the aquarium will have a setting particularly appropriate.

General Features.—The architects have designed a building that conforms to the best classical traditions. It will be built in the Greek Ionic style, in the form of an octagon. A central dome rising above the rotunda will be visible from every surrounding approach. The main entrance, through a portico of Greek Ionic columns will face towards Michigan Avenue on the center line of East Roosevelt Road now extended so as to skirt the Shedd Aquarium on the south and connecting with the new South Parkway, which was recently opened for traffic.

The Objects of the Aquarium.—The objects of the Shedd Aquarium will be both exhibitional and educational. So little is known about the denizens of the enormous areas under the surface of the seas, lakes and rivers that the exhibition of water life is a never-ending attraction for the public. Most people are at heart disciples of Isaak Walton and the study of the finny tribes holds for them romance and adventure. An aquarium, where specimens brought from every water can be observed at close range, affords the best place for the study of the aquatic animals.

There are at the present time only five large public aquariums in this country where salt water and fresh water specimens are exhibited, these, named in the order of their relative importance, being in New York, Boston, San Francisco, Philadelphia and Detroit.

The educational work of the aquarium will range from lectures in public schools to highly scientific laboratory work for advanced experiments in marine problems affecting the public at large, sportsmen, educators, and the fishing industry. The plateau at a level 32 ft. above Lake Michigan, upon which the aquarium is to be erected, will be encircled by monumental retaining walls, ramps, and stairways



Plant Placing Concrete for Storage Tanks

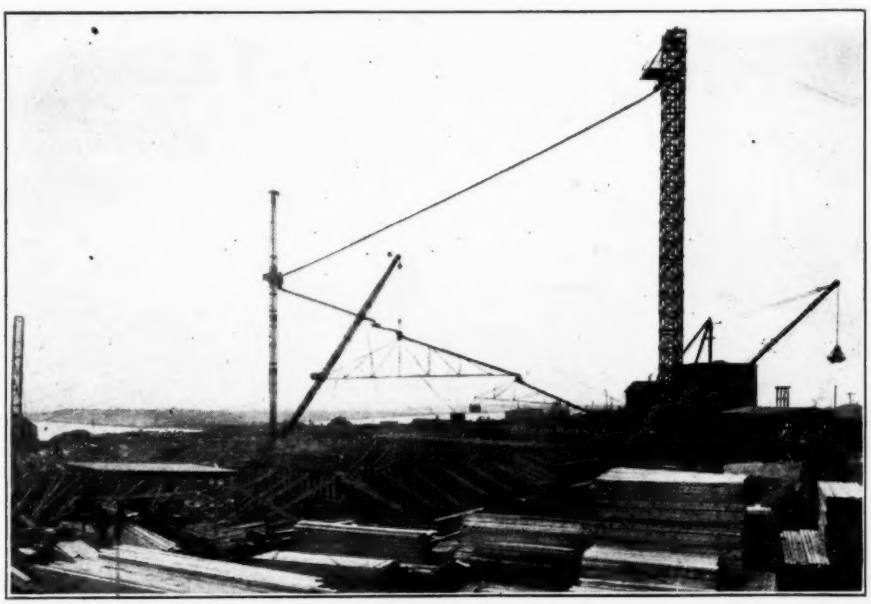
leading down to the lake level. The main floor of the aquarium will rise 16 ft. above the plateau to a level 48 ft. above Lake Michigan. The architecture of the aquarium will be in harmony with the architecture of the Field Museum and of the stadium to the south. The exterior of the building will be white marble. Withal the edifice will be an imposing one, enhancing the architectural beauty of the city.

The rotunda, the main feature and focal point of the interior upon entering the aquarium, will be designed in a dignified manner. Sculpture, bas-relief, and murals of subjects pertaining to sea life will be introduced and the rotunda will be lighted from the sky through a decorative skylight at the apex of the dome. In the center of the rotunda there will be a large circular well with a deep pool on the level of the basement floor which will be treated in a naturalistic manner.

Plans for the interior arrangement of the various galleries call for 1,000 lin. ft. of exhibits to include between 125 and 150 exhibition tanks and sunken gardens, varying in size to accommodate any species of marine life from the tiniest pond minnow to a 10 ft. shark.

Special halls will be maintained for model fish hatchery, balanced aquaria, and fishermen's museum. The hatchery will serve the two-fold purpose of exhibiting to the public modern methods of scientific propagation, and of hatching for the exhibition tanks the eggs of non-transportable fish life.

The usual facilities for the convenience of the public have been provided off the entrance lobby and the spacious hall, such as information booth, check room, and toilets. The balanced aquaria on the floor above back of the portico pediment, as well as the intricate mechanical equipment if the basement will be accessible for public view. A library, lecture room, and directors' office will open off the entrance hall. A large assembly hall will be provided in the basement, also the necessary mechanical and refrigeration plant, receiving and storage rooms and tanks for the various fish, which will be dis-



General View of Concrete Placing Operations for Storage Tanks at Shedd Aquarium

tributed in containers to the main floor exhibition tanks by means of elevators and overhead track system.

Storage Tanks.—In the basement will be 16 large concrete tanks for the storage of waste needed for the exhibits and hatchery. Rail facilities needed for shipments of water to the building were extended for the use of the contractors. A drive will enter the basement on one side and pass around to the other side affording opportunity for truck deliveries. An intake in the lake will afford a good supply of fresh water for condensing and exhibition purposes. No heating or lighting equipment will be needed, since such services are to be secured from the Field Museum by means of a conduit tunnel to be excavated and lined with concrete, passing under the drive to the basement of the museum. This floor will also contain brine cooling rooms, transformer room, switchboard room, pumps, etc.

Service Equipment. — The great quantities of water that must be handled, together with the cooling and aerating systems, make it necessary to install a great many specialized electrically operated pumps. For instance there are 3 pumps of 125 G. P. M. needed to handle tropical salt water, two at 75 G. P. M. and one at 50 G. P. M. needed to handle cool salt water, two at 50 G. P. M. and one at 75 G. P. M. needed to handle refrigerated fresh water, three at 125 G. P. M. to handle natural fresh water, plus two house pumps at 150 G. P. M. each, a 35 G. P. M. pump for the tropical pool, and two condensing water pumps at 600 G. P. M. each. There are to be about 50 electric motors from 1 to 150 H. P. for various purposes. Two gas fired boilers will be required to supply 2,500 sq. ft. of radiation and to raise the temperature of 6,000 gal. of fresh water 30 deg. per hour, and 15,000 gal. of salt water 15 deg. per hour from 45 deg. to 60 deg. respectively.

These points will give some idea of the magnitude of the job, as will the statement that the storage capacity of the basement tanks will be such that about $45,000 worth of water will be kept on hand at all times.

The architects for the John G. Shedd Aquarium are Graham, Anderson, Probst & White, Chicago. R. C. Wieboldt Co., of Chicago, is the general contractor.

How the Average Citizen Judges Municipal Government

Extract from the introduction to report "Measuring Municipal Government," by Clarence E. Ridley, published by the Municipal Administration Service.

Municipal government is constantly being measured or judged. Someone calls up the city hall and enters a complaint because a catchbasin on a certain street corner is flooded. A few days later the same person calls to report that nothing has been done about the complaint. "This administration is terrible," are likely to be his first words over the telephone.

If you were to ask the complainant how he knows the present administration is terrible, he would say either that the previous administration never overlooked such complaints or that the previous city he lived in never allowed its catchbasins to clog up. Although the city deserves to be censured for laxity, the unfairness of such a basis for comparison is evident. There may have been a good excuse for the apparent neglect of the complaint. And, even if there were no excuse, a single mistake or error is hardly a sufficient basis for condemning the work of an entire city administration. On the other hand, someone else may have received prompt attention to an equally trivial complaint; he is loud in his praise of the entire government. Certainly no administration should be appraised in its entirety on such insufficient grounds.

Occasionally, other more objective criteria will be applied. The physician will examine the death rate and perhaps appraise the entire city government as good or poor from this one fact. The club woman, interested in public welfare, will base her conclusions on the adequacy or inadequacy of poor relief. These are mere segments of the great circle of activities in which a city is engaged. To draw conclusions from too few data is as likely to turn good men out of office and let rascals in as it is to turn the rascals out and put good men in.

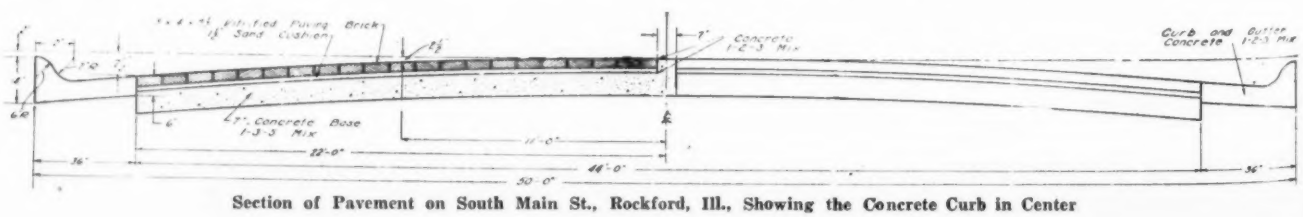
As Munro points out in his chapter on the criteria of good city government: "Two-thirds of the citizens know nothing about the tax rate. They are not property owners, and although they pay taxes indirectly (through landlords and merchants), most of them do not realize the fact. And as for the efficiency of the various city departments—such as police, fire protection, public works, schools and all the rest—the average citizen can see but a small part of the work and even as respects this small fraction he is hardly competent to form an opinion of his own."

For a number of years those interested in good government have been trying to develop some comprehensive means of measuring the work which cities are doing. So far they have developed few significant criteria. They have, however, laid a foundation on which future criteria will be based. They have proved that the element of personal judgment must be eliminated to a large extent before measurements of much value can be established. The best criteria are and always will be those whose worth does not depend on the way they are used. They should yield the same results for a given community regardless of who uses them or how they are applied. Of course this is an ideal. Probably the personal element can never be completely eliminated.

Methods of Water Analysis.—The methods used by the United States Geological Survey for analysis of the mineral content of waters are described in Water-Supply Paper 596-H which has recently been issued. This 27-page pamphlet is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at the nominal price of 10c.

50-Ft. Brick Pavement Has Concrete "Curb Traffic Marker" in Center

A brick pavement constructed last fall on South Main St., Rockford, Ill., has a concrete curb down its center. This served as a guide for the turnplate and now acts as a traffic marker. The pavement is 50 ft. wide and of the section shown in the illustration. The curb is a 1:2:3 mix. It was painted with whitewash before the asphalt filler was applied to the brick. This prevented the asphalt from sticking to the brick. The filler was heated to 390° and applied by the filler pot method. The concrete base is a 1:3:5 mix and only enough water was used to make the mass washable. B. C. Harvey, City Engineer, was the engineer, and A. E. Rutledge, Rockford, Ill., the contractor.



Section of Pavement on South Main St., Rockford, Ill., Showing the Concrete Curb in Center

Forethought in Planning for Future Developments of a City

How an Indiana City Has Solved Some of Its Problems

By D. B. DAVIS
City Engineer, Richmond, Ind.

IN THE proper plan of a city, the streets and pavements naturally act as the arteries and veins, through which transportation ebbs and flows. Like the veins of the human body, some must be larger than others, depending upon the volume of work to be accomplished. It seems then just as absurd to have too wide a roadway in a purely residential district, which would automatically attract commercial traffic and endanger the play of children, than it is to have too narrow streets in the congested business areas.

In the plan, there should be the main arterial highways and the minor ones which feed the traffic from the local centers along its length. Arterial highways should run as direct as possible, that the traffic flow, both from the county and state routes as well as from the local areas, may reach their destination in as safe and short a time as possible. The width of these will naturally depend upon the importance and the size of the community. Detroit and other large centers see a need for super-highways of a width of 220 ft., while the average city will be adequately served by widths from 80 to 100 ft.

When cities were smaller, many of the better residences were built along what has developed into through traffic routes, bringing with it a constant stream of transportation, both freight and passenger cars, with their noises and odors and speed which proves so hazardous to the lives of children.

The main street of many of these cities is usually one of these arterial routes, so consequently we see a gradual desertion of many fine homes along these streets to places more removed from confusion.

The Atmosphere of Cities.—All cities automatically provide themselves with the fundamentals of livelihood, but tell me what makes some places more attractive than others? What is that something, that on driving about a city that makes you say, "If I ever make a move I am coming here to live"? We may not be able to define it, but it may, in part, be a sense of orderliness and proportion that we feel and so admire. There is a distinct atmosphere about cities, just the same as of individual homes; when you go in them, either you feel welcome there and a desire to stay, or you wish to hurry off at your earliest convenience. The thing which we officials should seek to accomplish is to give that feeling of comfort and joy of living to our citizens, by the proper arrangement of its utilities.

The one thing which makes some cities progress above others, is due to an unselfish co-operation on the part of its citizens. Pity the city or individual in which no dissatisfaction regarding its welfare exists, for there you have an end to improvement.

It is possible to secure an excellent city if the citizens and officials exercise sufficient forethought in its development and administration.

It is comparatively simple to plan and build a new city, but the reshaping of an old one to fit changed conditions presents many knotty problems.

The City Plan Commission.—To bring the supervision of city planning to an issue and make it some one's particular job, many cities have created a city plan commission, whose purpose is to look into the future to foresee and arrange for the needs of a larger city, without unnecessary disturbance of the present one.

It is the aim of the commission to assist and by suggestions as to ways and means to bring about the development of undeveloped property. They desire, in the plats presented to them, that the streets be arranged in such manner that they lend themselves to the use proposed to be made of them and that they be as nearly coterminus as possible. They do not, however, encourage as wide a roadway for purely local residential sections as on main highways leading into the city or on main cross streets designed to carry a large volume of heavy traffic.

Wide Easements.—Wide easements, meaning total width of roadway, sidewalks and grass plots, are, however, desirable in residential as well as commercial sections, for the better beautification of the street by means of plantings. These wide easements surely lend a sense of freedom which is universally felt. One of the most important things to be accomplished is to get these wide easements while the land is vacant and unimproved. Richmond just completed a street widening along an addition laid out before a plan commission was in existence. The addition abutted against a section line road, leaving it only two rods wide. The most economical method to widen was to take a 40-ft. lot off of one side of the street, but even then it caused the removal of three houses and cost over $12,000. How much easier it would have been to have looked to the future when the plat was made out. Plan commissions which function at all will save the city many thousands of dollars and considerable worry in the future.

There is, however, an idea on the part of some, who think because there is a plan commission in a city that it is a panacea for all city ills. Few appreciate how limited is the authority given them.

Building Set-Back Lines.—Great saving can be accomplished in securing wider easements in business areas by the establishment of building set-back lines. This allows the desired widening to be accomplished over a period of time and at the least inconvenience and cost to the city and abutting owners.

A law was passed in Indiana in 1925 regarding set-back lines, but it does not apply to cities lower than second class. If any city needs such a law and if we are to profit by past mistakes, by deferring street widening until expensive structures have been erected, it is the smaller city which needs the law. In smaller cities the structures along the streets are of lower value than when they are replaced to accommodate the greater patronage coming with the enlarged city. Hence the time to establish set-back lines is in the early stages of the city.

In Richmond, in order to prevent loss of an opportunity to widen streets where new buildings are contemplated, the building commissioner is instructed to issue no permits where such contemplated building is to be located on a corner lot, without first bringing the matter to the attention of the board of works and the city engineer.

If it is found that the street is one which is planned to be widened, the board of works, with the city engineer, invite the owner into a conference upon the matter. A visit or visits, as may prove necessary, are made to the site and statements of purposes are made.

The purpose of the city in asking for a wider pavement is frankly stated to the owner. The city officials state their case in the most friendly manner, explaining problems of traffic, brought about by the ever increasing number

of motor vehicles, the need for increased parking space; reminding the owner of their duty as officials to look forward to the future need of the citizens; appealing to his sense of civic pride to assist them in that duty, yet all the while appreciating the owner's position and keeping in mind his side of the question. In this friendly yet businesslike way, is the matter brought along until the question of damages to the owner is reached.

Determining Damages and Benefits.—At first, some owners have an exaggerated idea of the amount of damages due them for a few feet of their property. It is, of course, perfectly human to endeavor to secure for themselves as much as is possible, especially from a corporation, which is erroneously supposed to be heartless.

Two methods of determining damages and benefits are explained to the owner, one which may be termed the legal way and the other which is the friendly or amicable way.

The legal way, which varies according to statutory procedure, and is more or less understood by officials. This is the customary method employed to widen and secure easements, but it has such a harsh and impersonal touch that, afterward, there seldom exists a friendly feeling between the parties concerned. Each one imagines the other has taken an unfair advantage of him.

In contrast to this legal method, is the amicable one, where the interested parties discuss the problem as heretofore stated, and come to an agreement without condemnation proceedings.

The proposition is made to the owner that in consideration of the dedication to the city of a strip of land, the width of which varies from 5 to 10 ft., the city will bear all the expense for reconstructing the walks, curbs and pavement. The work of reconstructing the pavement is done by the city forces under the street commissioner, thereby saving all unnecessary expense to the city.

In this plan, the officials in dealing with specific cases, not only want to feel that the owner is getting an equitable settlement, but we desire that the owners themselves will feel likewise, and when the thing is accomplished and it is as you know, invariably a wonderful civic improvement, there will still exist a friendly feeling on all sides. The owner is as proud, and deservedly so, as any one concerned in the matter.

Annexation.—There is a divided opinion regarding the advisability of adding to the city by annexation. I firmly believe in the idea of a city protecting itself by having a wide strip of open land about its developed territory; that it may exercise the necessary control upon its future growth. Notwithstanding the control of platting by the city plan commissions within a radius of five miles, the proper and complete control cannot be had when the land lies outside the city limits.

European cities formerly protected themselves by high walls and deep moats, but these now are occupied by circumferential boulevards following the route of these old walls. Civilized cities are putting their dependence in city plan commissions instead of walls and moats.

If we are to develop a high standard of living, all territory to be used for city purposes should at once receive the improvements to the land necessary for the use designed.

Sub-Divisions.—Wherever a city exists which is moving forward, there is to be found a horde of promoters ready to encourage the owners of open land to sub-divide it for speculative purposes. Many acres of good productive farm land is each year uselessly divided into lots, to lie vacant for years to come, yielding only an abundant crop of rank, obnoxious weeds to be cut and burned.

Sub-divisions laid out without improvements are naturally of lower value and consequently attract a lower class of structures than would come with the natural growth of the city. It also permits a scattered development, requiring a large amount of pavements, street lights and public utilities to serve a limited population.

If promoters were required to put up the necessary funds for the improvements to each lot, there would be less inclination to sub-divide unless they could see a real demand and sale for the lots.

It is just and proper for a city to expand but it should be done compactly and uniformly.

If boundaries are not laid along water sheds, it hinders the construction of drainage and sewer systems along economical lines. Under existing Indiana laws, sewer assessments are made on a square foot basis to benefited property. Trunk lines should be designed to care for the ultimate contributing territory, whether it be within or without the city limits. If only one-half of this benefited area is within the limits and the sewer is constructed, that part is penalized for the one-half cost lying outside the city; coming in later and connecting with the trunk lines without paying their share of the cost.

These sewer trunk lines should be constructed as far as there is any show of growth and use to be made of it; this same principle should apply to other city utilities such as pavements, water mains and electric service. The first thing asked by these selecting sites for new industries is the proximity of these utilities.

Utilities in 1 Sq. Mile.—It is of interest to see what cost is added to the city for the services paid by them from the general fund. To arrive at this I have taken a typical section in Richmond, 1 mile long and ½ mile wide and noted the items for which the city pays. These are listed below:

Utilities in One Square Mile of City	
16½ miles 6 in. water main	
1 mile 10 in. water main	
1 mile 12 in. water main	
1 mile 16 in. water main at 1 ct. per inch	$7,233.00
108 fire hydrants at $12.50	1,350.00
164 arc lights at $43.00	7,052.00
Collection of and disposal of garbage	2,151.00
Collection of and disposal of rubbish	5,126.00
Total	$22,912.00

Improving Vacant Plots.—In most cities, there are sub-divisions scattered here and there, where the major portion of the lots remain vacant. Often these plots occur in outlying districts where the present value of the lots are comparatively low. To have these spots remain unimproved, with the possible attraction of inferior structures, reflects a detriment to adjacent property.

For this reason, we in Richmond, make an effort to encourage some type of pavement construction for these plots.

We realize that these lots cannot stand to have the highest type of paving laid at once, so we have evolved a type pavement which has proved successful to us, yet inexpensive.

This type includes the use of 2 in. of cinders spread and rolled into the sub-grade. This acts as a stabilizer to the clay which prevails in our district. On top of this is spread a layer of local gravel to a depth of 5 in. To expedite the compaction of this gravel, 2 in. of crushed stone dust is spread and harrowed into the gravel and after being thoroughly wet, it is dragged and rolled alternately until hard and smooth. This foundation employs local materials and inasmuch as it resists no abrasion, furnishes a very stable base. For a surface 4 in. of No. 1 crushed stone is spread and waterbound. To protect it against dusting, we apply 1 gal. of tar per sq. yd., in two applications, and cover each application with No. 6 stone chips. After the final spread of chips, the surface is rolled. The cost of this pavement is $1.60 per sq. yd.

This pavement presents a very nice appearance and gives excellent service. After the street becomes built up with residences and they desire a higher type pavement, it is an easy matter to lay a bituminous resurface and the total cost, both of the initial pavement and the resurface, will not exceed the cost of some original modern type pavements.

For pavements receiving heavier traffic, Richmond is laying reinforced concrete pavements. These concrete pavements are built 8 in. in thickness and reinforced with 52 lb. of metal. A center joint is constructed with transverse joints every 50 ft. Richmond is a pioneer in using concrete for roadways, having laid their first job in 1896, which is still giving service.

Planting of Shade Trees.—Three years ago the Board of Works realized that if the beauty of its new streets were to match up with those of the old city, they must take some action to

have shade trees planted. Consequently, with each new street improvement, the item of shade trees is included. These trees are planted approximately 35 ft. apart and are of the same variety throughout the improvement. A 3 year guarantee is required.

The importance of street trees is far reaching. Their presence is the beauty of the street. Their absence causes defects to show up, such as buildings in disrepair, unsightly structures, which are seldom noticed when shade trees are present.

After the setting of shade trees, there is still a deep responsibility to the city for the care of them. Many cities have recognized this and have inaugurated the necessary rules and organization for city forestry work.

It requires many years for the maturity of shade trees even when they are properly cared for. Why should cities then defer the creation of forestry departments when they are of such vital good to the city?

Three years ago, the city plan commission secured options on all but one piece of land bordering a small creek just west of the corporation line. This land was low and mostly unsuitable for residences, but would make excellent park property. They knew it was but a year or so before the city would extend its boundaries and this creek would act as the natural water course for the storm water for that district. The land was purchased for $100 per acre; one piece having to be condemned at $150 per acre.

Since then the city has annexed territory ½ mile west of this park land and we are now ready to receive bids on a sanitary sewer 8 miles long over the entire district. Many buildings are being erected and soon it will be a regular part of the city.

If the city had not bought the low land where the creek flows, they would have been required to construct a storm sewer ¾ mile long, approximately 6½ ft. in diameter to care for the drainage. In other words, the city secured 35 acres for a park, which lies in the center of a residence district for approximately $3,500 and saved $40,000 on a storm drain.

A recent street widening finally consummated cost 15 per cent more by deferring it three years. This was caused by the district getting a factory and values increasing. The thing had been forseen and proposed early while values remained low but was retarded by objections.

Individuals and cities should profit not only by their own but by observing others' mistakes; if we do, they have proven profitable to someone, but if we make the same mistakes over and over, we have incurred great losses.

Civic progress is like a relay race; the work of one administration starts off where a preceding one leaves it; if it can become co-ordinated, real results will follow.

These accomplishments cannot be attained, however, by rubbing an Aladdin's lamp; like human character, it must be started early, persisted in and encouraged to attain the ultimate ideal.

Knowing as we do, that environment will determine to an extent, the conduct and well being of the people; it is our duty, as public servants, to raise the standard as high as we can, and though we cannot see the consummation of our plans, it may prove as an incentive to those who follow after us.

Acknowledgment.—The above is an abstract of a paper presented at the 14th Annual Road School.

A Sanitary Ash, Garbage and Refuse Collector

It is generally agreed that sanitation is the most important factor in the collection of refuse. Unsanitary methods of garbage collection endanger the health and welfare of the whole community.

A recent design of sanitary refuse collector is illustrated below. In this collector a 10-ft. trough comes down to the curb, receives the garbage, and lifts the contents into the body of the truck through a mechanical apron. All dust, garbage and refuse and odor are confined until the ultimate end of the journey. One man easily and quickly handles the loading, without lifting strains. The moment the truck leaves the curb the trough is back in its place and the contents confined.

This collector has been placed on the market by B. Nicoll & Co., 292 Madison Ave., New York City. It is made in two types, the dimensions being as follows:

Type	A-1	A-2
Capacity of body	10 cu. yd.	15 cu. yd.
Length of body	12 ft.	13 ft.
Height of body	4 ft.	4 ft. 6 in.
Width of body	6 ft.	7 ft.
Height of body from ground	10 ft. 10 in.	11 ft. 2 in.
Capacity of bucket	1 cu. yd.	1 cu. yd.
Length of bucket	10 ft.	10 ft.
Height of bucket	20 in.	20 in.
Width of bucket	22 in.	22 in.

Cold Weather Operation of Filters at Bangor, Me.

The following note on the winter operation of the filtration plant of Bangor, Me., is extracted from the 1927 report of James M. Caird, Chemist and Bacteriologist of the plant:

"At times of extreme cold weather ice has been formed in the rear of the filter units, under the concrete deck, but this has been overcome by reducing the 'head' of the water on the sand beds, which permits the air to circulate freely under the filter decks. In operating the filters during the cold weather, it is necessary to wash them every six to eight hours, otherwise they become 'air-bound' and permit undesirable water to pass. The 'air-bound' conditions commence when the temperature of the water is below 45° F. When the water is warmer it is possible to operate the filters from 16 to 24 hours between washings."

Recreational Facilities at Detroit, Mich.

The per capita cost of the recreation system of the city of Detroit was less than 8 ct. per capita in 1927. In that year 7,500,000 people attended recreational activities at the 31 playgrounds and playfields. The city now owns 549 acres of recreational areas, not including parks. Of the people using the playgrounds in 1927 42 per cent were adults and 58 per cent children.

New Street Signs at Portland, Ore., and Toledo, O.—Portland, Ore., has authorized the purchase of 9,000 new street signs. This is the beginning of a four-year program of 9,000 new signs per year at an expenditure of $40,000. Toledo, O., will spend $25,000 for new street signs in 1928, and a like amount next year, if the present program is carried out.

Front View with Bucket Down. Bucket Raising—Dual Control by Loader or Driver. Dumping—Driver Controls Rear Door and Body Raising. Dumps at 45° Angle

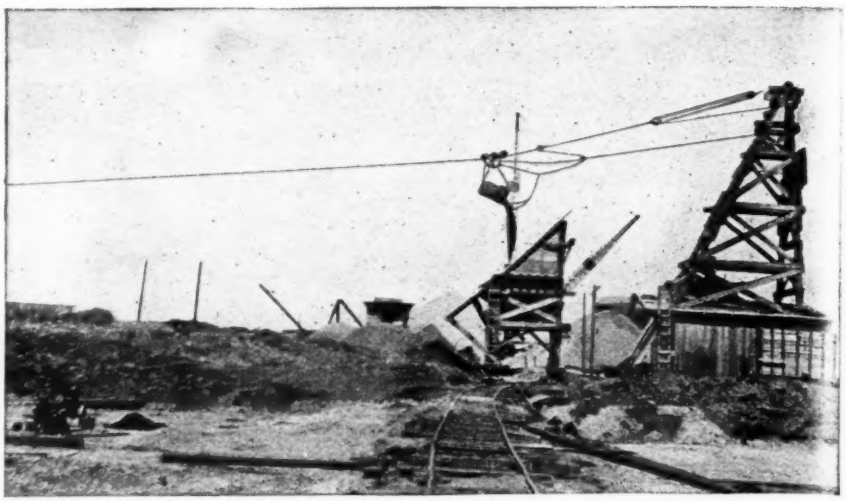
Concrete Aggregate Produced While Digging Plant Site

Ingenious Use of Equipment in Building Sewage Disposal Plant

IN the construction of the Imhoff tanks for a new sewage disposal plant for the city of Dayton, O., the E. H. Latham Company of Columbus has an ingenious equipment layout that ties together in a simple and effective manner the operations necessary for making the excavation, obtaining the aggregates for concrete, and placing concrete in the forms.

The excavation required for the Imhoff tanks on this project is approximately 250 ft. long, 250 ft. wide and 20 ft. deep. The site of this excavation is, by good fortune, on a deposit of excellent sand and gravel. Since considerable quantities of these materials are needed for later concrete work, it was only natural to save the material from the excavation and to include a small screening plant in the equipment for the project, so that the sand and gravel could be properly prepared for concrete.

The sand and gravel is covered by an overburden of approximately 5 ft. Below this, however, there is left some 15 ft. of excavation through the usable material.



Gravel From the Excavation Is Dumped Into a Movable Hopper in Front of the Traveling Head Tower

For making the excavation itself, the Latham company is using a 1-cu. yd. Sauerman slackline cableway excavator. The placing of the mixed concrete, after the excavation has been completed and the forms placed, will be done by a tautline cableway and concrete buckets.

To simplify both of these operations, the company installed two movable towers that are moved along the sides of the excavation. These towers are now being used to support the Sauerman cableway while the excavation is being made, and they will serve later to support the tautline cableway while concreting is in progress.

The towers are built of wood, supported on rails, and are of a standard design for the operation of a tautline cableway. The slackline cableway excavator, however, was easily adapted to this anchorage. The head tower supports the 2-drum hoist operating the slackline, as well as the mast-top assembly of operating blocks. The lower end of the slackline cableway trackline is attached to a bridle at the base of the tail tower. When the tautline is installed it will be attached, of course, to the peak of each of the towers.

Excavating for Imhoff Tanks at Dayton Sewage Disposal Plant. The Pit Will Be About 250 Ft. Square by 20 Ft. Deep

Since the slackline cableway is moved along the excavation as fast as the work progresses, it was not feasible to build the screening plant so that the cableway could discharge directly to it, as in the usual installation. The material from the pit is being handled very easily, however, by means of a movable hopper which receives the load from the cableway bucket.

This hopper moves on rails between the excavation and the head tower, as shown in one of the illustrations. Under the hopper is a narrow-gauge track, and small industrial cars receive the sand and gravel from the hopper and carry it to the screening plant at one side of the construction site. The screened materials are being stored in large piles and will be reclaimed later when the concrete mixing begins.

The E. H. Latham Co. was awarded the Dayton sewage plant contract only a few months ago. The excavation for the Imhoff tanks began early in the spring, and as this article is being written is practically completed. The Sauerman cableway, operated on a span of 400 ft., has averaged about 350 cu. yd. of material per 8-hour day, and has made records as high as 470 yd. a day.

Softening Municipal Water Supplies By Use of Zeolite

Experiences at Two Large Scale Plants in Pennsylvania

By J. T. CAMPBELL and D. E. DAVIS
Of the J. N. Chester Engineers, Pittsburgh, Pa.

ABOUT four years ago the Ohio Valley Water Co. authorized its engineers to report upon a plant for softening the water supplied by that company to a suburban population of 60,000 people on the Ohio River just below Pittsburgh, Pa. The water delivered averaged about 3,200,000 gal. per day and is derived from wells drilled in the river channel to bed rock through 30 to 40 ft. of sand and gravel, which has been deposited in the rock-cut channel of an older river.

The water from this underground source conforms to the characteristics of a true ground water, and is generally about twice as hard as the river water flowing immediately above.

There is apparently very little direct and immediate communication between the river water and the underground flow, as is indicated by the chemical characteristics of the two waters, and also by the fact that the well water is comparatively pure while the river water is highly contaminated.

Quality of the Water.—The quality of the water and its variations may be noted from Table I:

It will be seen that the soap hardness averages somewhat over 200 ppm. The hardness of the City of Pittsburgh water as taken from the Allegheny River is more nearly 80 ppm. and the contrast was sufficiently marked as to offer occasion for considerable complaint on the part of the users of the harder water. However the markedly high manganese content (over 2 ppm. as Mn.) brought forth the major portion of the registered protests from housewives, because of the discoloration of clothes during laundering, and the staining of porcelain fixtures.

The manganese was also a source of trouble and expense to the water company since it tended to become deposited (as M_nO_2) upon its mains and particularly in its service lines, often stopping the latter completely, and threatening to seriously curtail the carrying capacity of the lines.

The goal set for the proposed improvement therefore looked to the elimination of the iron and manganese content of the water as well as that of supplying the consumers with a softer product.

Table II—Comparative Annual Cost Estimate for Lime-Soda vs. Zeolite Softening

Lime-Soda		Zeolite	
Labor and supervision	$ 6,000.00		$ 6,000.00
Lime, 242 tons @ $12	2,900.00		
Soda-ash, 550 tons @ $37	20,350.00	Salt, 2,200 tons @ $8.60	18,920.00
Alum, 60 tons @ $25	1,500.00	Wash water	1,970.00
Coke (for carbonizing) 180 tons @ $10	1,800.00		
Wash water	500.00	Additional pumping cost	3,030.00
	$33,050.00		$29,920.00
Fixed charges and maintenance	$10,000.00	Fixed charges and maintenance	$10,000.00
	$43,050.00		$39,920.00
Cost per millions gallons:			
Operating	$ 28.30	Operating	$ 25.60
Fixed	8.60	Fixed	8.60
	$ 36.90		$ 34.20

Zeolite and Lime-Soda Processes Considered.—A zeolite softening plant for the treatment of the boiler feed water for this plant had been in successful operation for about two years prior to the time when studies were begun for the softening of the entire supply, and due to the favorable impression which this installation had made on the management, it was suggested by F. B. Beech, the general manager, that this method as well as the lime-soda process be considered. Space considerations entered into and affected the calculations since the plant was located at the head of Neville Island, and occupied the larger part of the land there owned by the company, so that there was comparatively little room for the construction of new facilities. The lime-soda process, as conceived, would have involved some form of sedimentation and chemical storage facilities as well as filtration. In contrast, the zeolite plant could be constructed and housed over a concrete chlorination basin already in existence, and the chemical storage problem conveniently and economically solved by building concrete brine tanks with tops a little above ground level into which salt could be shoveled from boxcars set on the railroad switch paralleling the tank.

The comparative cost estimates for the two projects based on a four million gal. per day plant showed that there would be no great difference in first cost between the two plants, and that an expenditure of about $100,000 would be involved, including certain improvements in low service pumping.

Comparative Cost Estimates.—The comparisons were made for an average pumpage of 3,200,000 gal. per day and a hardness reduction from 190 ppm. to 60 ppm. with the results given in Table II:

As will be seen later the assumptions as to salt requirements and costs were conservative and in practice the salt costs have been materially less than estimated, and the cost per million gal. in 1927 was $27.20.

The zeolite plant made a still more favorable impression when the cost argument was reinforced by the saving of space; the avoidance of "mess and grief"; and the assurance of ease and "fool-proofness" of operation of the zeolite as compared to a lime-soda plant.

There remained one obstacle to a decision to proceed with zeolite softening in that there was no available precedent in large-scale municipal plants whose experience might be sought for guidance in this enterprise, nor was it definitely known how effective the zeolite material might prove in the removal of iron and manganese. The company therefore employed Robert Spurr Weston to study the chemical features and in conjunction with the plant chemist and bacteriologist, H. C. Kneeland comprehensive experiments were conducted on the boiler feed zeolite softener. In the meantime Henry Hass, the president of the Ohio Valley Water Co., investigated certain hotel installations on the Pacific coast, and their observations proving favorable, it was decided to proceed with a zeolite installation.

The Zeolite Installation.—The en-

Table I

Chemical Analysis Made in 1923

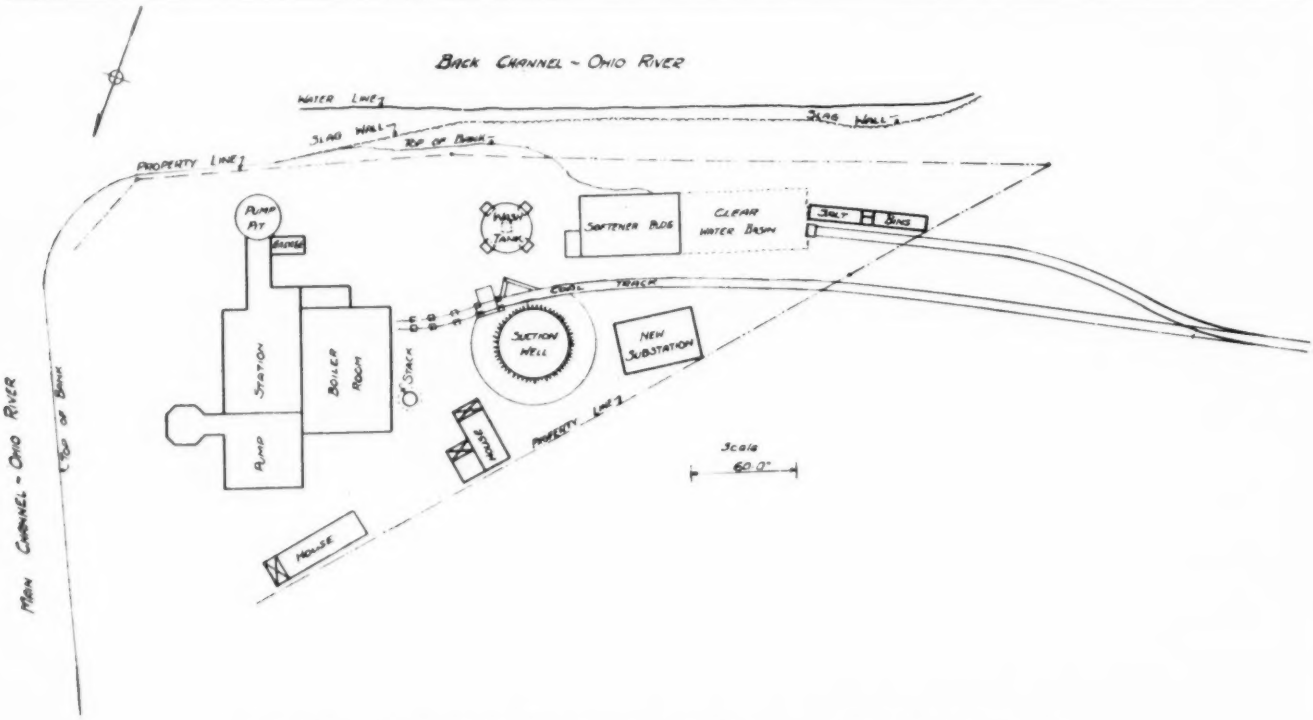
CO_2	10.0
Fe and Al	6.3
SiO_2	9.5
$CaCO_3$	84.0
$CaSO_4$	141.0
$MgSO_4$	20.2
HaCl	36.0

Tabulation of Alkalinity and Hardness

Year	Alkalinity Min.	Alkalinity Max.	Total Hardness Min.	Total Hardness Max.
1920	53	96	121	212
1921	89	106	178	218
1922-23	71	97	142	254
1926	....	....	200	250
1927	....	....	209	293

closed steel-shell type of softener was chosen for this installation for the reason that more capacity could be installed in a given space than with open type beds, and space was at a decided premium at this plant. When the design was begin it was soon discovered that there was a deficiency in the information on some hydraulic and technical details, and consequently it became necessary to carry on some experiments on some smaller commercial units to determine this data. The head required to force the water through the bed, and the rate of flow through the bed under constant head conditions, were some of the questions requiring clarification.

While the pumps, delivering water low duty pumps located in two circular pump pits whose bottoms were at approximately river level and whose tops were above extreme high water. These pumps delivered the water into a covered rectangular concrete basin 130 ft. long by 35 ft. wide by 20 ft. deep whose flow line was ground level. This basin acted as a retention basin or clear water storage it being baffled by a center wall, extending the entire length of the basin to within 20 ft. of the end wall. The water entered on one side of this dividing wall, received its dosage of chlorine from Wallace & Tiernan liquid chlorine machines located alongside the basin and flowed the length of the basin, around the end of the baffle wall and tem for collecting the soft water and distributing the wash water. The wash water is carried off by means of a perforated pipe trough located 14 in. above the surface of the zeolite. Each unit has a sand area of 208 sq. ft. and operates at a rate up to 1,500,000 gal. per day, at the beginning of a run to 1,100,000 gal. per day at the end of the run. The valves on the filter piping are controlled hydraulically from an operating table located in front of the unit. The units are designed to permit a total loss of head of 14 lb., a portion of which is made up of negative head gained by carrying the soft water outlet pipe down into the clear well below the water line and trapping it.



Plan of Property and Buildings of the Ohio Valley Water Co., Neville Island (Bellevue) Pa.

from the wells through the softeners, would be capable of furnishing the requisite water for the washing of a single filter, yet there would be a serious curtailment in the softening rates of the remaining units unless the pumpage were supplemented from a storage reserve. It was therefore decided to install a wash tank which, besides furnishing wash water, also served several other useful functions, including that of an equalizer whereby the heads on the pumps were maintained nearly constant; (thereby insuring good efficiencies) and likewise delivery of the softeners (so far as affected by changes in head) sustained at a nearly uniform rate, which was but little effected even when water was being taken from the tank for washing and regenerating an exhausted filter.

Previous to the installation of the softening plant the water supply was pumped from the wells by horizontal back to a receiving chamber at the front end of the basin and from thence to a circular suction well 40 ft. in diameter from where it was picked up by the high service pumps and pumped into the distribution system.

It was decided to place the softening units on top of this retention basin, the roof and walls of which were reinforced to take the additional weight. The softening units consist of four steel pressure tanks 9 ft. in diameter and 22 ft. long set in a horizontal position and supported on a concrete slab set directly on top of the roof of the clear water retention basin. These units are housed in a brick building which also contains a salt solution storage tank and brine pump and a laboratory and office.

The Softening Units.—Each tank contains a 40 in. depth of zeolite sand underlaid with 18 in. of gravel, below which is located a pipe under-drain sys-

A wash water tank having a capacity of 15,000 gal. is floated on the line between the low duty pumps and the softener units and acts in a two fold manner; first, to provide water for backwashing the units and second, to take up the differences in rate of softening due to the fact that while most of the time three units are operating and one is being regenerated, there are short periods when all four units are delivering water and since the pumpage is at a constant rate the tank supplies the excess water needed at this time. Orifice meters are provided on the inlets to the units and measure the rate of softening and also the rate of washing.

Salt Storage and Brine Distribution.—The salt storage and brine distribution are designed to give simplicity of operation. A salt charge of about 6 to 10 tons of salt is required per day which is shipped to the plant in box cars

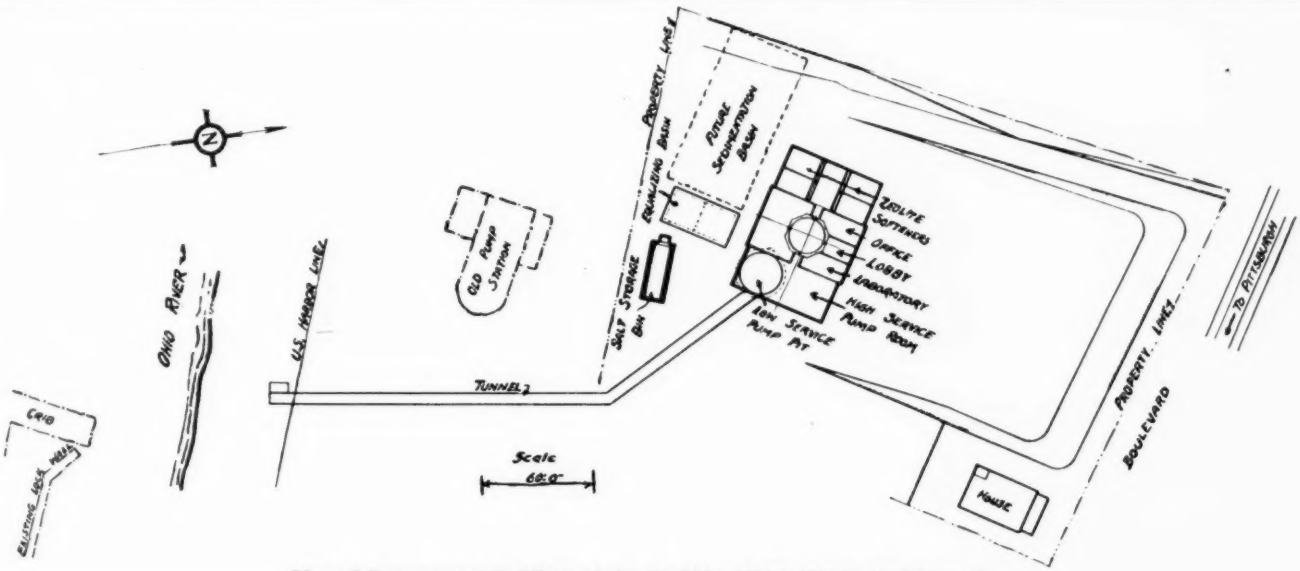
and shoveled from these cars into a double compartment concrete bin each compartment being 29 ft. long by 8 ft. wide by 13 ft. deep holding two weeks supply. The top is level with the ground and the bottom is hopper shaped and contains gravel graded from 3 in. to 1¼ in. underlaid with an open joint tile line. The salt is dumped into the bins and is covered with water, dissolving the salt and giving a saturated solution which is collected by the tile under-drain and carried to a solution well between the two salt compartments. This well is divided into two compartments in one of which is located a centrifugal pump for pumping the saturated brine solution up into the brine tank in the softening building from which tank it is pumped into the softener units as needed.

water. Since it had been the intention to deliver a final product to the consumers containing a hardness of about 70 parts per million, the softeners continue in operation about an hour longer, turning out hard water to mix with the soft so as to maintain the average product at about 70 ppm. All water is run through the filters in order that the manganese, iron and crenothrix may be removed, and to obtain such advantage of filtration as the passage of the water through the unit (regarded as a filter) would effect. The rate of flow through the unit is about twice the ordinary rate for rapid sand filters, and were the water contaminated, appreciable removals of bacteria might be expected. At Ohio Valley the final product is practically sterile before chlorination.

about five minutes, after which the drain valve is opened to waste, while the influent valve is "cracked" to allow "rinse" water to pass down through the bed at a rate of about 3 gal. per sq. ft. per minute for about 25 minutes, during which the chloride solutions are washed from the bed.

This regeneration period averages 30 to 40 minutes, and on completion the unit is held idle until an interval of about 5 hours has elapsed from the time when the softener was first put on the line. This 5 hour period represents the full "run" for a single unit, and as there are four units it will be seen that for a short time they are all delivering water, but that over much of the time one unit is being regenerated while the remaining 3 units are in operation.

The well water varies in hardness



Plan of Property and Buildings of the Sewickley Water Works, Sewickley, Pa.

Cost of Softening Units.—The cost of constructing the softening units complete together with all auxiliary equipment is as follows:

Wash Water Tank	$ 3,425.00
Salt Bins	8,712.34
Building and Foundations	11,046.63
Softener Units Complete with Zeolite	39,000.00
Piping, Valves, Meters, Operating Table, etc.	10,153.34
Pumps and Wiring	4,278.30
Railroad Siding	814.76
Labor—Other Than in Contracts	5,200.80
Miscellaneous	1,102.44
Engineering and Interest During Construction and Overhead	11,015.17
Total	$94,748.78

Operating Methods.—There were several alternatives open in the fixing of operating schedules and methods, but the plan finally adopted at the Ohio Valley Water Co. has proved quite simple and effective in practice. A unit, upon being started after regeneration, is given a "run" of about five hours. During approximately 3⅓ hours the unit turns out a water of zero hardness, and for a short period thereafter the water delivered varies uniformly from zero up to the full hardness of the well

At the end of this 4⅓ hour period, the unit is taken out of service and given a back-wash from the tank for 4 minutes at the rate of about 4.75 to 6 gal. per sq. ft. per minute. In the meantime a remote control push button has started the small brine pump at the salt storage tank outside the station, and has delivered a saturated brine solution to the small steel brine tank beside the softener units. The quantity delivered is measured to a nicety by hook gauges, and when the level of the upper hook gauge is reached the pump is stopped, and a second brine pump inside the station is started and pumps the measured brine solution into the exhausted unit through the perforated pipe manifold extending the length of the tank at the top.

The mixture of this saturated brine with the water above the sand gives about a 10 per cent solution. The drain valve is opened enough to pull this solution down into the sand, and the gate is then shut, allowing the solution to remain in contact with the zeolite

through the year, although the rate of change is quite slow and in operating practice it has been found advantageous to so fix the schedules that the period of operation or run for each tank is kept constant, and changes in hardness are met by varying the salt dose. In this way the variables are reduced to a minimum, and the operations can be subjected to a definite routine which do not overtax the abilities of ordinarily intelligent laborers under capable supervision. The problem of stopping at the end of the day is very simple since the entire plant is shut down, the softeners cut out of service, and the schedule picked up on the following day at the same relative point.

In the early operation the hardness of the well water was reduced gradually; a period of about two months elapsing between the reduction from about 180 to 54 ppm. This procedure was followed partly because it was thought that with the introduction of soft water, patches of the manganese deposits might break their moorings and leave by the route

of the house spigots, but experience has shown that these deposits are being gradually dissolved, and no complaints have been received because of "gobs" of blackness.

The plant during its 2½ years of operation has proved to be remarkably free from trouble and has been a model of "fool-proof" operation. Only two incidents have enlivened the steady routine. On one occasion a "gravel hill" developed in one unit which seemed to indicate a blown out strainer. This condition was quickly remedied without untoward results. On another occasion (about one year after the plant was built) the filter seemed to suddenly "plug up," and refused to pass the usual quantities of water. When a manhole was removed it was discovered that a well-matted growth of crenothrix had formed a blanket about ¾ of an inch in thickness over the top of the bed. This was removed to reveal what appeared to be virgin zeolite immediately below. Since that time inspections have been made monthly and once every month a longer period of washing has been given, with the result that no further difficulties have been experienced.

From all indications the zeolite can be used indefinitely, since the reversible reaction between sodium and calcium-magnesium does not tend to break down the zeolite grain or to decrease its base exchange capacity. The losses of sand due to abrasion seem to be low, since only 100 cu. ft. or approximately 3.7 per cent of sand has been added in two and one-half years (including the replacement occasioned by the removal of the the crenothrix mat with its embedded sand) or at the rate of 1.5 per cent per year.

Operating Features.—The salient operating features for this plant are incorporated in Table III.

The wash and rinse water has averaged about 10½ per cent of the output of the plant. In 1926 there were approximately 2,270 grains of hardness removed per cubic foot of zeolite with a salt dose of 0.328 lb. per 1,000 grains removal; while in 1927 the corresponding figures were 2,520 grains and 0.364 lb. respectively. For this plant and taking into account the costs of salt and wash water, it would appear that the most economical salt dose is in the neighborhood of 0.35 lb. per 1,000 grains of hardness removed.

The operating costs as set forth below are based on an expenditure of $95,000 with interest charged at 6 per cent, depreciation at 3 per cent, and maintenance at 1 per cent. The maintenance costs have been substantially nil to date, but it is thought only fair to make provisions for what is likely to occur at some time. The item for "Pumping Additional Head" represents the cost of lifting the water the additional height over that necessary under the former low lift conditions, as required to force the water through the closed softener units.

Tabulation of Annual Costs

	1926	1927
Labor and Supervision	$ 5,955.00	$ 6,409.00
Supplies and Expenses	278 00	199 00
Salt	11,362.00	14,667 00
Wash Water	637.00	540.00
Pumping Additional Head	2,482.00	2,162.00
Mineral	100.00	100 00
	$20,814.00	$24,077.00
Interest, Depreciation and Maintenance	9,500.00	9.500.00
Total	$30,314.00	$33,577.00
Per Million Gallons:		
Operation	$ 17.30	$ 19 24
Fixed Charges	7.90	7.56
Total	$ 25.20	$ 26.80

The original cost estimates were conservatively made on the basis of 0.5 lb. of salt per 1,000 grains removal, and $8.60 per ton salt cost, whereas the plant has been able to run on a 0.346 lb. and $6.475 per ton basis respectively, which represents a material saving.

The consumers have been enthusiastic about the soft water, particularly the housewives, since the job of laundering and cleaning has been made much easier. It has been difficult to obtain exact data as to the savings in soap, washing powder, etc., but from general inquiries and observations the savings approximate sixty per cent (by weight). The sale of soap powder and laundry soap has almost ceased. No difference in taste between the hard and soft waters has ever been reported, and the sodium salts remaining in the water do not offer any objections in domestic or commercial use.

The Sewickley, Pa., Installation.—A similar problem developed at Sewickley, Pa., in 1927, and in making comparisons between lime-soda and zeolite softening there was available the detailed operating data on a modern lime-soda plant as designed by this firm for Greenville, O., as well as the zeolite plant at the Ohio Valley Water Co. The Greenville plant was equipped with mechanical mixing tank, Dorr Clarifier and carbonizing equipment, and was operating on the excess-lime principle, effecting excellent reductions in hardness on a favorable cost basis.

Sewickley is a community of about 5,000 people situated on the Ohio River about twelve miles below Pittsburgh. Its supply is a ground water, derived from a crib sunk into the gravel bed of the river, and is clear and substantially pure at all times. Chemical analyses taken at intervals over several years show variations in alkalinity from 80 to 100 and in total hardness from 170 to 215, and an analysis of a sample taken April 25, 1927, is as follows:

Calcium carbonate	118
Magnesium carbonate	7
Calcium sulphate	56
Magnesium sulphate	15
Sodium sulphate	37
Oxide of iron and alumina	0.8
Sodium chloride	27

The crib water is of such excellent quality from a sanitary standpoint that it was decided to continue it in use, but as there was a remote possibility that an accident might damage the crib and permit contamination from the river; and also that at some future date the river might be used as a source of supply, it appeared advisable to design the units so that they might be employed as filters if necessary.

Comparative Costs.—A comparison of the cost of a lime-soda softening plant with a zeolite plant, each of two million gallons per day capacity, but to operate on a twelve hour schedule and to deliver 1,000,000 gal. per day average, and 130 ppm. is set forth in Table IV:

The comparison was so clearly in favor of the zeolite softener as to indicate its adoption, and plans were

Table III—Operation of Softening Plant of Ohio Valley Water Company, Bellevue, Pa.

Month	Gallons Water Treated	Gallons Wash Water	Average Hardness in ppm. Untreated	Before	After	Pounds Salt Used	Average Pounds of Salt Per Thousand Grains Hardness Removed	Cost of Salt Per Ton	Cost of Salt Per Million Gallons
Nov., 1925	91,939,980	9,180,000	160.0	53.83		334,250	0.494	$6.60	$12 00
Dec., 1925	92,477,085	9.440,000	193.4	86.37		240,000	0.350	6.60	8.56
Jan., 1926	94,529,465	11,500,000	219.5	81.12		237,200	0.319	6.60	6.28
Feb., 1926	87,236,600	11,580,000	202.7	66.37		224,625	0.324	6.60	8.52
Mar., 1926	97,479,975	10,200,000	204.0	68.74		240,926	0.312	6.60	6.16
Apr., 1926	91,442,725	9.450,000	196.9	68.6		218,106	0.319	6.60	7.87
May, 1926	100,549,900	10,720,000	198.2	69.11		244,452	0.336	6.60	8.02
June, 1926	95,492,005	10,000,000	234.4	74.77		286,477	0.325	6.60	9.90
July, 1926	109,780,680	11,260,000	248.7	64.14		390,990	0.331	6.60	11.79
Aug., 1926	111,251,460	11,080,000	246.0	68.68		395,050	0.341	6.60	11.30
Sept., 1926	107,040,300	10,800,000	234.0	65.74		329,450	0.312	6.60	9.77
Oct., 1926	109,962,405	10,740,000	241.0	71.		332,325	0.303	6.60	9.60
Nov., 1926	98,167,680	9,820,000	237.0	68.6		294,600	0.317	6.60	9.52
Dec., 1926	100,263,855	10.380,000	233.0	64.		310,800	0.315	6.60	9.84
Total	1,203,190,000	127,540,000	2695.4	830.77		3,505,000			
Average	100,266,000	10,628,000	224.6	69.23		292,900	0.328		
Jan., 1927	104,627,720	10,300,000	216.0	63.0		311.150	0.342	$6.35	$ 9.43
Feb., 1927	92,492,855	9,570,000	211.0	62.3		265,175	0.331	6.35	9.10
Mar., 1927	101,713,175	10,832,000	209.2	63.0		289,300	0.337	6.25	9.03
Apr., 1927	100,698,100	11,010,000	210.4	67.0		293,695	0.349	6.35	9.26
May, 1927	104,273.140	11,172.000	216.5	67.2		297,000	0.328	6.35	9.04
June 1927	106,898,560	11,054,000	233.0	68.9		332,675	0.325	6.35	9.89
July, 1927	119,625,821	10,850,000	284.0	87.0		512,425	0.373	6.35	13.60
Aug., 1927	109,543,082	12,030,214	266.0	95.0		508,200	0.470	6.35	14.73
Sept., 1927	105,672.324	11,770,000	253.8	77.0		428,800	0.369	0.35	12.86
Oct., 1927	105,513,040	11,572,000	293.0	82.0		492,150	0.407	6.35	14.81
Nov., 1927	98,579,698	10,626,006	284.0	70.5		462,200	0.376	6.35	14 89
Dec., 1927	101,621,880	10,245,645	251.0	68.0		393,450	0.364	6.35	13.34
Total	1,251,514,000	131,030,000	2927.0	872.9		4,558,000			
Average	104,293,000	10,920,000	244.0	72.7		379,800	0.364		

Table IV—Comparative Cost Estimates for Two Million Gallon Per Day Softening Plant

	Lime-Soda		Zeolite
First Cost (softening plant only)	$88,000.00		$65,000.00
Fixed Charges	7,040.00		5,200.00
Labor	3,600.00		3,600.00
Maintenance, etc	600.00		600.00
Lime, 122 tons @ $14	1,708.00	Salt, 550 tons @ $6.50	3,575.00
Soda-Ash, 122 tons @ $34	4,148.00		
Alum, 20 tons @ $25	500.00	Additional wash water	105.00
Coke, 55 tons @ $12	660.00		
	$18,256.00		$13,080.00
Average cost per million gallons:			$ 21.65
Operating	$ 30.80		14.15
Fixed	19.20		
Total	$ 50.00		$ 35.80

drawn on the basis of the open, rapid sand filters employing zeolite sand as the softening medium. The status of the patent situation on zeolites was in a highly unsettled state at this time, in fact some of the important court decisions, plant consolidations and company understandings were announced between the time the plans were started and the letting of contracts. In order to secure competition alternate plans were designed to that definite competitive bids could be obtained on (a) downward softening, (b) upward softening, employing green sand (glauconite) or synthetic zeolite in either case. Bids were received on each scheme. The finally accepted bid called for three beds of green sand for downward softening, and one bed of ordinary quartz filter sand for supplying wash water and filtered hard water for mixing with the zeolite-softened product, in order that the water, as delivered to the consumers, might have a hardness of about 60 ppm.

The Water Supply.—Water is drawn from the crib, buried in the gravel formation below the bed of the Ohio River 75 ft. from shore, through an 18-in. cast iron suction pipe carried in a concrete box culvert 4 ft. 3 in. wide by 5 ft. high with bottom approximately at pool level. This culvert or tunnel terminates in a circular concrete well 23 ft. in internal diameter by 40 ft. 6 in. deep, the bottom being approximately at pool level and the top on the level of main pump room floor. This pit contains two 1,400 g.p.m. low duty motor driven centrifugal pumps, with space reserved for a future third pump. These low duty pumps deliver into a concrete equalizing basin in the rear of the plant having a capacity of 40 minutes for a 2,000,000 gal. per day rate and divided into two units so designed that if in the future it should become necessary to abandon the crib and use raw river water these basins could be converted into mechanical mixing chambers for receiving coagulants and a sedimentation basin could be built in the space reserved for same alongside this equalizing basin. From the equalizing basin the water will pass directly into the softening and filtering plant consisting of four units of 182 sq. ft. each or a total capacity of 2,000,000 gal. per 24 hours based on a rate of 2 gal. per square foot per minute. These units are of the standard rapid sand type having steel wash water troughs whose top edges are located 30 in. above the top of the sand and 30 in. of sand laid on 18 in. of gravel graded from ¼ in. up to 3 in. in diameter. This gravel rests on a concrete bottom under which is a false bottom having an open space of 20 in. for admitting wash water and equalizing its distribution. The top of this false bottom contains ⅜-in. brass strainer nipples 6 in. on centers, into the top of which are screwed umbrella type brass strainers, so designed that the loss in pressure when washing at a rate of 15 gal. per square foot per minute will not exceed 2 ft.

The sand in three of these units consists of green zeolite sand having an effective size of 30 mm. and that in the fourth unit is quartz sand having an effective size of 40 mm. Water will pass downward through all four filters at the rate of 2 gal. per square foot per minute, being filtered in its downward course through all four filters and in addition being softened to zero hardness in the three zeolite sand filters. The rate of filtration is controlled by means of rate controllers located in the outlet pipe from each filter, the three softening filters delivering into a soft water clear well located under two of the filter units and the main floor lobby on one side of the pipe gallery and the fourth filter delivering filtered but hard water into a hard water clear well located under the other two filters on the opposite side of the pipe gallery. These two clear water wells or basins are connected into a third well or high service suction well located under the other half of the lobby floor. By this arrangement there is approximately three times as much soft water as hard water admitted into the high service suction well so that the mixed water pumped into the reservoirs through a rising main by the high service pumps has a hardness of about 50 to 60 parts per million.

All four filters will be washed upward at a rate not exceeding 15 gal. per square foot per minute, with wash water taken from the hard water clear well by means of a wash pump located on the high service pump room floor.

The three zeolite sand filters are regenerated by means of a brine solution pumped from a brine polution tank in the pump room basement by means of a motor driven centrifugal pump and delivered on the top of the zeolite sand through orifices in the pipe lines located directly under the wash troughs.

This brine tank in the pump station basement receives saturated brine solution from concrete brine bins located outside the building adjacent the equalizing basin and constructed similar to the brine storage bins previously installed for the Ohio Valley Water Co. softening plant.

Two high service motor driven centrifugal pumps each having a capacity of 1,300 gal. per minute and located on the main pump room floor will take their supply from the mixed water suction well and will deliver it through a 10 and 12-in. cast iron main to a series of reservoirs located on a hill above the town from whence it will flow by gravity into the distribution system.

The operation of the plant has been simplified as far as practical, hydraulic operating valves being furnished for each filter unit, with loss of head and rate of flow gauges on each operating table. An indicating wash water and brine gauge has been provided so that the exact rate of washing and feeding of brine solution can be told by a glance at the gauge. A vacuum pump has been provided for priming the pumps, and also a clear well gauge and a high and low water alarm connected to the clear well.

In as much as the plant must be capable of handling contaminating river water which might by accident get into the crib or low duty suction main through a break, a dry feed machine and a chemical storage floor have been provided so that alum can be mixed with the raw water before it enters the equalizing basin and thus form a mat on the surface of the filter sand.

Two Wallace & Tierman liquid chlorine machines of the vacuum pedestal type have been provided for sterilizing the water in the clear water wells.

This plant is now under construction, the substructure having been ready for the brick work at the time of writing this paper.

The contract prices are as follows:

Substructure	$ 59,343
Superstructure	53,500
Filter Equipment	22,490
Filter and Softening Material	10,650
Pumps and Wiring	12,676
Total	$158,659

It is anticipated that the units will each deliver "zero" water for a period of approximately 4½ hours, at the rate of about 2 gal. per square foot per minute, maintained uniformly by the rate controller. The unit will continue in service about two hours longer, during the early part of which the water will pass from zero to full hardness, and during the latter part a completely hard water will be delivered. The remaining water required to produce a water of 60 ppm. hardness will come from the quartz sand filter. The normal period of regeneration should be about ½ hour,

making the total "run" of a unit about 7 hours.

The two cases here presented relate to water which are initially clear and relatively pure and which have a fairly high percentage of permanent hardness; an ideal situation for a zeolite plant. In such cases the plant cost can be kept lower than with the lime-soda process since the cost of brine storage will be less than storage for lime, soda ash, etc., and the mixing chambers, clarifiers, sedimentation basins, and carbonating apparatus, which are vital elements in a modern lime-soda plant can be largely eliminated from a zeolite plant. These savings will be considerably greater than the cost of zeolite compared to quartz sand.

The Sewickley softening units are designed like rapid sand filter units, but with green sand or zeolite substituted for quartz sand. Provisions are made for the introduction of alum to form a "schmutz decke" on top of the sand if necessary in affecting purification. Since a high rate of wash (15 gal. per square foot per minute) is provided, these units may be thoroughly cleaned and the full softening capacity of the sand maintained. The units will be delivering water for less than 7 hours per run between regenerations, or a period during which the loss of head will be comparatively low, insuring against negative heads and the release of air in the filters, which air would prevent obtaining the full exchange capacity of the sand by keeping the water away from that part of the sand which is air-bound.

Under these conditions small amounts of sediment in the water reaching the softeners could be handled, but in the case of muddy waters, sedimentation basins or roughing filters would need to be interposed ahead of the softeners. In one case recently considered, such a combination indicated economics as compared to the lime-soda process.

A combination of the lime-soda and the zeolite process might prove advantageous under certain circumstances, especially where muddy waters and those high in temporary hardness were encountered. Lime could be employed to bring down much of the temporary hardness and after carbonating the water, it could be carried to a zeolite softener where it could be reduced to "zero" hardness if necessary, or stopped at any predetermined point between.

The results in full-scale operation have been so successful as to warrant the belief that the zeolite process of softening may be found advantageous in the solution of many municipal softening problems. The simplicity of the regenerating process; the case with which it lends itself to definite operating schedules; the assurance of control over the final product; freedom from after-deposits as sometimes occur with the lime-soda process; the absence of dust and handling problems incident to lime-soda plants, and the factor of economical operation are features which make the zeolite process attractive and worthy of consideration where conditions are favorable.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1928 convention of the American Water Works Association.

Paving Brick Association Appoints Q. A. Campbell Secretary

Quincy A. Campbell has been appointed acting secretary and assistant to the managing director of the National Paving Brick Manufacturers' Association.

Q. A. Campbell

Mr. Campbell was born in Bellefontaine, O., in 1891, and entered the Civil Engineering course at Ohio State University, completing three years of the course before enlisting in the military service in the summer of 1917. During the World War he served as instructor in the Aviation Ground school at Ohio State University and at Kelly Field, Texas. After receiving his discharge from the Army in 1919, he became assistant engineer for the city of Hamilton, O., returning to Ohio State University that fall and received the degree of Bachelor of Civil Engineering in 1920.

After graduation he spent the next year in engineering work in the Republic of Santo Domingo. Returning from there in the summer of 1921, he entered the Ohio Department of Highways as an Assistant Engineer, being later appointed Assistant Division Engineer and serving in that capacity at Ravenna, O., for five years. In 1927 he was promoted to the position of Assistant Chief Engineer of Maintenance, with headquarters at the Columbus office of the Ohio State Highway Department, which position he has resigned to enter his present employment.

George F. Schleisinger, who until recently was director of highways for the state of Ohio, assumed his duties as chief engineer and managing director for the National Paving Brick Association on July 1, 1928.

Forest-Program Committee Proposes 10-year Plan

Representing various local interests and the Massachusetts Forestry Association, a committee of eight has drawn up a 10-year plan for the protection and rehabilitation of the forests of Worcester County, Massachusetts. The committee recommends that the county be divided into four districts of about 150,000 acres each and that a woodland owners' and a forest wardens' association be formed in each of these districts. These associations would be in a position to employ foresters and cooperate effectively in carrying out forest protection, forest management, and forest-utilization plans.

Other recommendations include the extension of State forests to cover 10 per cent of the forest land of the county, consolidation of public forest lands, acquisition by the State of lands in districts where private owners may be slow to apply forest management because of the fire hazard, more educational work with schools and other organizations and by preventive patrol, the installation of adequate fire-fighting equipment, including power pumps and of permanent fire-protection crews on State forests, the erection of two additional observation towers in the county, the acquisition by each town of fire-fighting equipment to include at least 12 extinguishers or hand pumps, 12 shovels, 12 wire brooms, and a conveyance for transporting men and equipment, and the hiring of a patrolman by each town during dangerous fire seasons.

The county contains 970,000 acres of land, of which about 630,000 acres is in forest or brush pasture. The committee estimates that there are about 350,000 acres in the county better adapted for forest production than for any other crop. At present the county has 127 factories engaged in making products, of which wood is the chief material. The greater part of this wood and over 80 per cent of the lumber used in building is imported from the South and the Pacific coast. The rehabilitation of the forests of the county, therefore, bids fair to be a paying enterprise on more than one count.

Two Unusual Types of Pavement

Cement Macadam and Sodium Silicate Surface

MACADAM With Quick Hardening, Cement Binder.—This pavement known in France as cement macadam. It somewhat resembles a pavement constructed sometimes in the United States as Hassam pavement. The cement macadam surface consists of a layer of crushed stone of 3 in. to 2½ in. thick after rolling, which is filled with a mixture of lumnite cement and screenings. The screenings are mixed to a slightly damp consistency and swept and rolled into the road as would be done in ordinary waterbound work. Rolling is carried on exactly as in waterbound macadam and sufficient water used to harden the cement. The surface is a compacted thickness of about ¾ in.

One sack of cement is used for each 13 sq. yd. of cement macadam surface. After completion the road surface receives a treatment of approximately 2 qt. of emulsified asphalt or tar with stone chips sufficient to cover.

Figure 1 shows filler being mixed with cement in cement macadam construction. Fig. 2 shows a cement macadam base rock filled with cement screenings. Due to quick hardening of high alumina cement this type of surface may be used within a day after its construction.

Sodium Silicate Pavement.—Figure 3 shows a sodium silicate street surface in Brives, France. This unusual type of construction has found some favor in France, where traffic is light and where funds are not available for more expensive road work. It is essential that the stone consist of a pure limestone and that it be free from appreciable amounts of siliceous matter. In practice it is usual to take the stone out one year before use in order to entirely free it from any clay or dirt which might stick to the stone. The same result would probably be accomplished by thorough washing. Stone for the first course is from 1½ in. to 2½ in. in size. Fines and filler from the same stone, including dust, is mixed with 58° Be. sodium silicate in proportions of about 10 gal. to each cubic yard of fine material. The mixing may be accomplished in a concrete mixer. The mortar produced is spread over the coarse stone with a shovel. The coarse stone and mortar is then mixed on the road, using forks, and this is followed by steam rolling with a roller weighing about 12 tons. In some cases the coarse stone and fine material are mixed with sodium silicate in a concrete mixer. During the rolling operations the sodium silicate and limestone mixture comes to the surface in yellow patches. Rolling is continued until this color becomes uniform and until it is a paste or batter over the surface. When this condition is reached the road is considered as complete.

Acknowledgment.—We are indebted to C. L. McKesson, Materials and Research Engineer, California Division of Highways, for the information and photographs used in this article.

Fig. 1—Cement Macadam Construction—Mixing the Filler With Cement

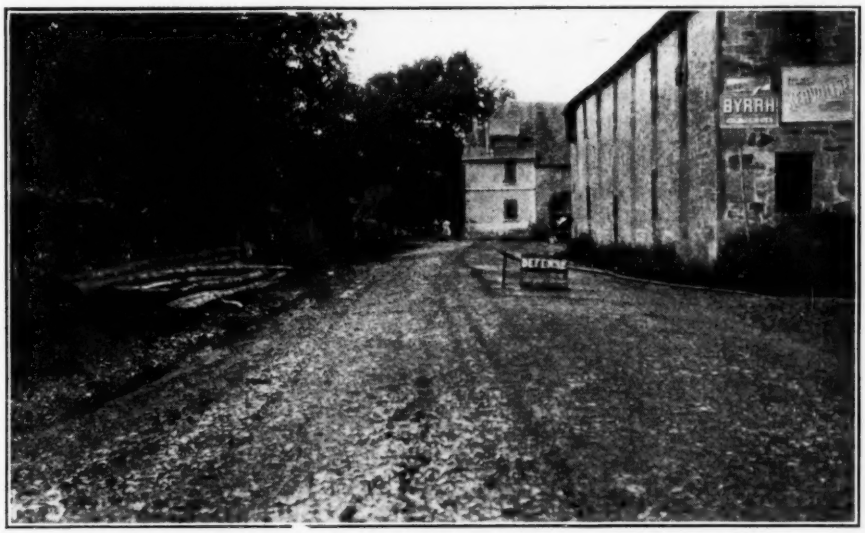


Fig. 2—Cement Macadam Base Rock Filled With Cement and Screenings

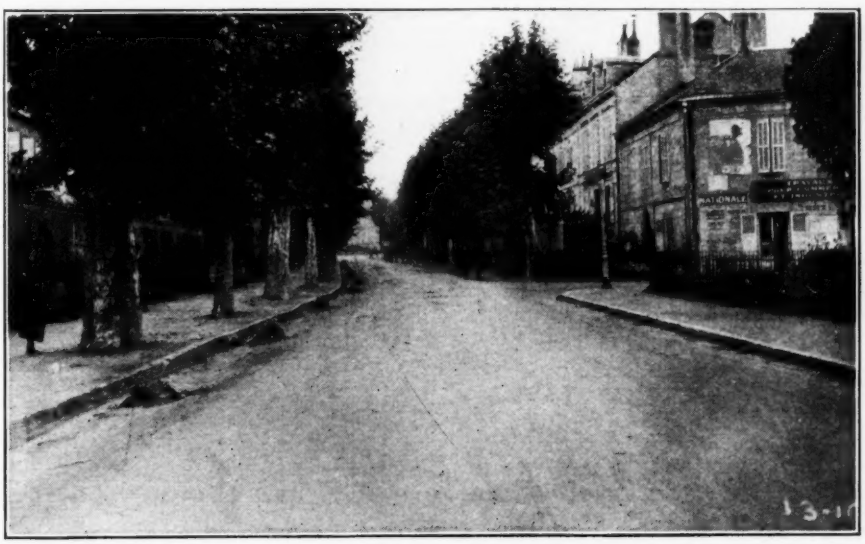


Fig. 3—Sodium Silicate Street Surface in Brives, France

Cleaning Sewers By Flushing

Notes on English Practice

By F. JOHNSTONE TAYLOR

IN flat districts the engineer concerned with sewerage work is confronted with a relatively difficult problem. Good sewerage from a sanitary point of view demands that sewers shall have a self-cleansing velocity. On the other hand, present day practice requires as a rule that they shall have a capacity of at least six times the dry weather flow, and, in addition, provision must be made for increased volumes of sewerage at a later date. The result is that in many instances it is necessary to put in sewers which, for some years after their completion at any rate, will not satisfy hydraulic considerations in respect of a self-cleaning velocity on account of the limited fall available. To some extent this difficulty can be overcome by the use of oval sewers which have a relatively large depth of water on the invert in relation to small flows, but this class of sewer is only practicable for fairly large mains and it is moreover costly to construct. A large amount of average sewerage work can be carried out by means of pipes, either of fireclay, stoneware or concrete as may be deemed desirable, and if at normal flows they become sluggish resort must be had to flushing. At the same time sewer flushing requires to be judiciously carried out because the necessary apparatus adds to the cost and in practice is not always as effective as it might be.

Sewer Flow.—A study of sewer flow has revealed that the solid matter in sewage is carried either by dragging, intermittent suspension or continuous suspension. In respect of dragging the following velocities are necessary in order to commence motion of the materials named:

Material	Velocity in ft./sec.
Fine sand	0.50
Coarse sand	0.75
Road detritus	0.80
¼-in. gravel	1.00
½-in. gravel	1.25
1-in. gravel	1.80
1½-in. gravel	2.25
2-in. broken stone	3.30
2½-in. broken stone	3.80

The material will be found to always move with a velocity of less than the stream, the mean velocity of the material being about 0.60 of that of the stream. Depth of flow is a very important factor in determining the motion by dragging. Broken stone, for stance, of 2½ in. gauge which is listed above will only just move at the velocity mentioned in 1 in. of water, but with a depth of 6 in. motion is quite easy when the velocity is but 2 ft./sec. In other words, the transporting power of the liquid in a sewer varies with its depth. The water wave on striking a particle is deflected from its rounded surface, and this resistance to deflection does greater work on the particle if the stream is deep than if it is shallow. In a deep stream the water strikes the particle under greater pressure due to the greater head and its translational energy is greater although the bottom velocity is not dependent on the depth of flow to as great an extent as is surface velocity.

Of considerable trouble in sewers is road detritus. This certainly only reaches the sewers in time of storm, when there should be sufficient velocity to carry it off to the outfall. But heavy road detritus requires a mean velocity of 2½ ft./sec. and 4 in. depth of flow to clear it away and quite an appreciable amount is left in the sewers after the storm has subsided if these conditions are not realised by normal flows.

Motion by Suspension.—If one purposely puts solid matter in a sewer—fine material, for instance—it will be found that though motion is commenced by dragging, the particles are more or less rapidly lifted up into the stream and motion is carried on by suspension. The greater amount of material is carried in the lower layers of the stream, the amount being proportional to the depth. Motion, too, is seen to be from the sides towards the centre, the majority of the suspended matter being carried along the center of the stream. The amount or the size of the matter carried in suspension depends upon the velocity of the stream and its depth of flow and to a greater extent upon the latter, because in a deep stream the particles are thrown to a greater height than in a shallow one and as the velocity of descent of the particles is the same in both cases, the deep stream carries the particles further owing to their greater opportunity of remaining suspended.

Failure, therefore, to deal with the solid matter is in pipe sewers, at any rate, due to insufficient depth of flow rather than velocity, and especially is this condition evident in lateral sewers which only receive intermittent discharges from the dwellings connected to them. Thus deposits are formed which require periodical removal by flushing. If such deposits are not removed a filmy growth appears on the pipe wall. This growth in turn reduces the velocity and so matters go from bad to worse, with the additional evil of the production of large volumes of sewer gas and over septicising of the sewage which adds to the difficulties of treatment. In general it is advisable to provide means for flushing pipe

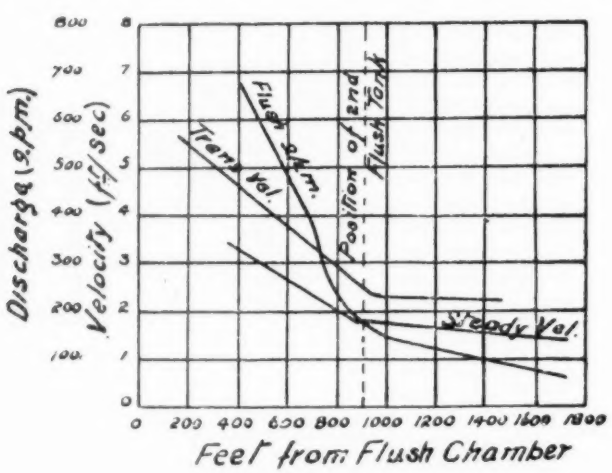


Fig. 1.

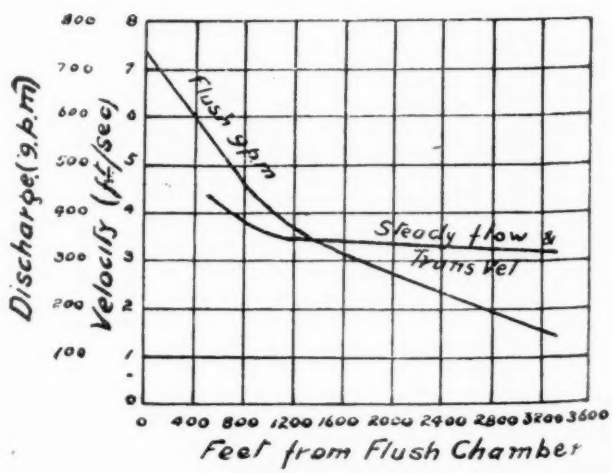


Fig. 2.

sewers when the gradients are flatter than those indicated below.

12 in.	diameter	1-200	21 in.	diameter	1-500
15 in.	diameter	1-300	24 in.	diameter	1-600
18 in.	diameter	1-400	27 in.	diameter	1-750

Effects of Flushing.—It is not necessary to describe here the usual arrangement of flushing chamber beyond stating that it should be designed to discharge the water at a high velocity 1,000-1,500 gal. per minute by means of a syphon. It is not necesary to use in the aggregate a very large amount of water, as flushing need not as a rule be done at intervals of less than 12-24 hours, but when the flush does come down it should all but fill the sewer. The depth of flushing wave decreases from the flush tank end to a point downstream at which the depth and velocity are but little affected by the discharge. Take, for instance, a 12-in. sewer, and assume a 1,500-gal. tank discharging in 1¼ min. through a 10-in. syphon. With a gradient of 1-630 the condition of affairs is indicated by the diagram in Fig. 1. On this diagram are shown two curves designated as the curve of transmission velocity and the curve of steady flow velocity. In respect of the first named the rate of transmission at the commencement of the flush and at different distances from the flushing chamber is that which would give the maximum scouring velocity if the flush were discharged into an empty sewer. This velocity lasts but a few seconds, and its effect reaches but a short distance. In respect of the steady flow velocity during the period when the maximum quantity of flushing water is passing at different distances from the flushing chamber, it will be seen that this velocity lasted for a minimum period of 1 min., the time increasing with the distance from the flushing chamber. There is also a curve showing the maximum quantity of flushing water in gal. per min. at different distances from the flush chamber. From this curve the effect of varying the amount of flush water discharged per min. can be determined. As a comparison one may refer to Fig. 2, given by the same authority in respect of a 9-in. sewer with a flush of 750 gal. for one minute. Examination of these curves reveals the fact that:

(1) The velocity dies off rapidly at first until it attains a certain value after which the diminution is small. In consequence the flush is transmitted over quite long distances, possibly up to one mile.

(2) With flat gradients, the velocity when the maximum quantity of flush water is passing is less than the rate of transmission at the commencement of the flush, the difference gradually decreasing as the gradient decreases, until as indicated in Fig. 2 the velocities are identical. It would appear therefore that the slope of the advancing flush will gradually flatten as the distance from the flushing chamber increases except where the gradient is such as to secure a high velocity. It is noticeable also how the steady flow velocity is over 3 ft./sec, at a distance of more than 3,400 ft. from the flush chamber. If, therefore, the sewer gradient is reasonably good, though less than the minimum value previously advised, and a good flush is rapidly discharged, the sewer can be kept clean for at least half a mile even though its capacity is considerably in excess of normal flow.

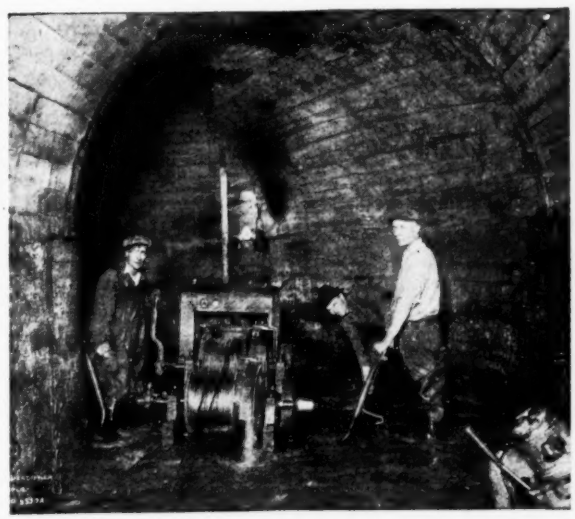
Referring again to Fig. 1, which may be further analysed, on the flush being discharged into a manhole from which the upper portion of the sewer was cut off by a flap valve, the water rose 27 in. in the manhole and the hydraulic gradient for the first 360 ft. is increased from 1-630 to 1-120. At 900 ft. where it will be noted another flushing chamber is placed, the steady flow velocity is 1.9 ft./sec., and the transmission velocity 2.5 ft./sec. The influence of the flush was found to produce a good scour up to 1,200 ft. when the steady flow velocity was only 1.7 ft./sec. with a transmission velocity of 2.4 ft./sec.

Acknowledgment.—The above article is reprinted from the Commonwealth Engineer.

Portable Scraper Outfit Cleans Debris from New Sewer

A portable scraper power unit was used by the Northern States Contracting Co. for removing debris from a newly completed sewer at St. Paul, Minn. The sewer, of 12-ft. horseshoe shape, was 4 miles in length.

In order to get the power unit down into the sewer, it was necessary to remove the drums and the motor and reassemble the unit after it was inside. The power unit was set up near a manhole and by operating the "Screscent" scraper on a 300-ft. drag, all the muck and debris between two manholes could be cleaned out at one set-up; then the equipment would be moved on to the next manhole. Three laborers were used in the sewer; one to run the power unit and two to handle shovels. As fast as the material was piled up under the manhole by the scraper, the shovelmen loaded the material into buckets, which were hoisted to the surface with hand winches.



Removing Debris from a 4-Mile Sewer with a Sauerman Portable Scraper Unit

Locating Leaks With an Aquaphone

The following useful suggestions on locating leaks with the aquaphone was given by E. O. Sweet, Chief Engineer, Birmingham Water Works Co., Birmingham, Ala., in a paper presented at the recent convention of the Southeastern Water and Light Association.

If you send a man out to locate leaks with an aquaphone, make him take along a hydrant wrench and a curb stop key. Insist that if he hears a leak on a service that he close the curb stop and listen again. If he does not hear it then, the leak is beyond the meter, and he should stop long enough to ascertain if the meter is catching the leak. If he hears a leak on several services in the block, make him stop long enough to find on which service it sounds loudest. This is the point nearest the leak and it will save time for the repair men to have this knowledge. Another inexpensive and quick way of finding leaks in our larger cities is to send men through the large trunk storm sewers. Many leaks have we found by so doing. Another quick method is to look into all telephone company duct manholes. Water will often be found entering their ducts and flowing to a manhole.

One Hundred Per Cent Payment of Water Bills at Bangor, Me.—The 1927 reports of the Water Board of Bangor, Me., contains the following interesting item: "We can again report that the payment of water rates has been 100 per cent, indicating the success of the balanced method used in the collection department. It has been necessary to shut off only one service for non-payment of water rates. With an estimated yearly turn over of some 30,000 accounts, this reflects exceptional credit to the water takers."

Detroit Now Has Best Lighted Street in the World

On July 10, the new 5-light ornamental illumination system on Washington Blvd., Detroit, Mich., was officially placed in service, making the boulevard with its tall buildings on either side a veritable canyon of artificial sunshine

The lighting standards, placed in double rows along the parkway in the middle of the street, are unique in many respects According to illuminating engineers of the General Electric Company, who designed the system, they are the most distinctive used anywhere in the country. The illumination per pole, 10,500 candlepower, exceeds State Street, Chicago, heretofore America's best lighted street, by more than 1,000 candlepower. The glassware used to house the lamps is also of record-breaking size. This is also the first installation having large Mazda lamps in groups of five to a standard.

The trustees of the Book Estate, visualizing some years ago the development of this wide boulevard into one of the finest retail shopping centers, included in their plans a most comprehensive scheme of lighting—one that would place the boulevard among the finest, lightest streets in America.

These tentative lighting plans were turned over to W. D. A. Ryan, director of the illuminating engineering laboratory of the General Electric Co. at Schenectady, who with his technical laboratory staff worked out the engineering plans and with J. W. Gosling of the laboratory, the art work in connection with the standards and globes.

The engineers made numerous tests and surveys, and adopted a plan of location and spacing of standards which, coupled with the size and design of the lamps, gives maximum diffusion and distribution of light.

Each standard has five specially designed Novalux units, 24 by 36 in. in size, each equipped with a 1,500-candlepower incandescent lamp, mounted on King ornamental standards 32 ft. in height. The equipment will furnish more than 2,000 lumens per lineal foot of street frontage. This is 20 times as much light as previously used on Washington Boulevard.

The glass globes are designed with a scheme of corrugation that refracts the upward rays, directing them laterally and thus conserving light that is usually wasted.

The city lighting commission previously served Washington Boulevard with as much light as other downtown streets, but on account of the unusual width of the boulevard it was considered inadequate.

All five lamps on each standard are to be lighted every night until 1 o'clock; the uppermost light will remain in service until morning.

Institute of Municipal Administration to Be Held at University of Southern California

6-Day Course of Lectures and Round Table Discussion

AN Institute of Municipal Administration is to be held at the University of Southern California, Los Angeles, Aug. 13th to 18th, according to announcement of President R. B. vonKleinSmid. It will be attended by mayors, managers, commissioners, city and county officers, and citizens actively interested in public affairs.

Covering a scientific and practical study of modern municipal administration, the August Institute will include an intensive 6-day course of lectures and round table discussions on city planning, municipal finance, street traffic control, public health, municipal engineering, social welfare, legal problems of municipalities, public institution, recreation, and park administration, city clerkship administration, councilmanic problems, and county administration.

Lectures by Nationally Known Authorities.—Sessions, to be held mornings and afternoons on the S. C. campus with public lectures in the evenings, will be headed by experts in municipal affairs from cities throughout the country. Nationally known authorities who are to lecture include the following:

William B. Munro of Harvard University, vice-president of the National Municipal League, who is to discuss a Survey of the Organization and Forms of Municipal Government.

John Edy, City Manager of Berkeley, Cal., and President of the International Association of City Managers.

C. M. Spofford, Chairman of the Department of Civil Engineering at Massachusetts Institute of Technology, and a specialist on bridge construction.

Harland Bartholomew of St. Louis, city planner for forty municipalities, a member of the Board of Governors of the American Institute of City Planning, and Director of the City Planning Division of the American Society of Civil Engineers.

Miller McClintock, Director of the Erskine Bureau of Street Traffic Research at Harvard University, vice-president of the National Safety Council, and consultant of the San Francisco Survey Committee, the Chicago Association of Commerce, the Los Angeles Traffic Commission, and to the cities of Boston, New Orleans, Providence and Knoxville.

Francis Hiller of New York City, Field Representative of the National Probation Association, and a member of the Juvenile Dependency and Delinquency Section of the Institute.

Edwin A. Cottrell, Professor of Political Science at Stanford University, who is to head sessions on General Principles of Government.

Abel Wolman, Chief Engineer of the State Department of Health, Baltimore, Md., to head the section on Sanitary Engineering.

Ira V. Hiscock of Yale University, Bacteriologist of the Connecticut State Department of Health, and Commissioner of the Board of Health of the City of New Haven, Conn., who is to be special lecturer on Public Health at the Institute.

Otto Schreiber, head of the Institute on Air Law at the University of Koenigsberg, Germany, who is to head sessions on Air Law.

Other experts will head sessions on municipal budgets, city clerkship administration, city and county attorney's problems, and civil service.

Faculty members of the University of Southern California on the Special Committee which formulated the courses and cooperated with the technical committees in arranging the program include Emery E. Olson, Director of the Institute; Dr. Justin Miller, Dean of the S. C. School of Law; Dr. Earle F. Young of the School of Social Welfare; Professor Roy T. Malcolm of the Department of Political Science; Professor T. T. Eyre of the College of Engineering; Professor T. H. Ross of the College of Commerce; Professor William R. LaPorte of the Department of Physical Education; Professor O. R. Hull of the School of Education; and Dr. Julio Endleman of the College of Dentistry.

Indicating the widespread interest among the lay public whose influence is of increasing importance in public affairs, an advisory board of citizens not in public office include prominent men and women from San Francisco; Helena, Montana; Fresno, Cal.; Idaho; Ventura, Cal.; West Texas; Pasadena, Cal.; Jerome, Ariz.; Alhambra, Cal.; Oakland, Cal.; Phoenix, Ariz.; Stanford University; and Inglewood, El Segundo, Monrovia, Fullerton, Bakersfield, Glendale, and Los Angeles, Cal.

The Institute membership will cover Arizona, Utah, Nevada, Idaho, Colorado, New Mexico, Texas, Montana, Wyoming, Washington, Oregon, and California, according to Mr. Olson, the Director, who states that registrations are already being received to indicate that hundreds of students will attend the one-week school of city and county affairs.

Technical committees of public officers who have cooperated with the University of Southern California in creating the curriculum include the Association of City Planners, with Charles H. Diggs of the Regional Planning Commission as Chairman; the City and County Engineers Association, with W. K. Knowlton, City Sanitation Engineer, Los Angeles, as Chairman; the Treasurers, Auditors and Assessors Association, with George H. Wood, Auditor, Pasadena, as Chairman; the Association of City Clerks with Victor McCarthy, City Clerk of El Segundo, as Chairman; the City and County Attorneys Association, with Jess Stephens, City Attorney of Los Angeles, as Chairman; and the Juvenile Dependency and Delinquency Section, with Mrs. C. Raymond Bradford as executive secretary, and Judge Robert H. Scott of the Juvenile Court of Los Angeles as Chairman.

Civic, professional and business leaders, chambers of commerce, the California League of Municipalities, the California Real Estate Association, and the Health Officers Association have endorsed and sponsored the Institute by their hearty cooperation and active interest, according to Director Olson.

The Institute Program.—Registration of the members of the Institute is scheduled to begin Saturday, Aug. 11th, at the University of Southern California, Bovard Administration Building, 35th and University Ave., Los Angeles. It is planned that the visiting group from the Pacific Coast and Rocky Mountain states will attend the Hollywood Bowl concert on that evening. On Sunday, Aug. 12th, as a preliminary program of the Institute, an ensemble meeting of all the sections will gather in Bovard Chapel at 3 p. m., and the delegates are to attend the Pilgrimage Play in its unique outdoor setting "en masse" on Sunday evening.

The Institute will open officially on Monday, Aug. 13th. Morning lecture sessions, luncheon talks, and afternoon round table discussions are planned, with some of the topics to be covered announced below.

The series of six sessions to be headed by William B. Munro will cover the relation of the city to the state; municipal home rule, its value and its limitations; the city charter; the mayor-and-council form of government; the commission plan of government; the organization of city departments; the city manager plan; and the forms and functions of county government.

Constitution and powers of the City Planning Authority will be the first topic under the general heading City Planning and Zoning to be headed by Harland Bartholomew; transit and

transportation plans covering grade crossing elimination, railroad terminals, and the bus in urban transportation, will follow. A model zoning ordinance; relation of zoning to the building code and housing laws; and the Board of Appeals will also be discussed. Public recreational facilities, civic centers, signs, lighting, and street trees are also listed as important lecture subjects. The cost of public improvements, public bond issues, special taxes, and excess condemnation also come under the City Planning Section of the August Institute.

Taxation, assessments, audits, and budgets involved in municipal administration will be covered in a separate section, with sessions on personal property valuation, improvement valuation, legal powers and duties of financial officers, budget control, audits of city's revenue and expenditures, and municipal reports and financial statistics.

Illustrated by lantern slides, the Section on Street Traffic Control will begin with a graphic lecture on traffic characteristics of typical American cities, by Miller McClintock, Director of the Albert Erskine Bureau of Street Traffic Research at Harvard University. The traffic accident problem with suggestions for successful methods of relief, the use of special control methods, parking and pedestrian problems, automatic and mechanical control of traffic, and community organization for traffic relief are also among the subjects to be covered.

City Clerkship Administration is scheduled for a group of intensive sessions, to include consideration of licenses, charts, election laws, legal publications, handling of ordinances and resolutions, control of purchase of supplies, and systematizing the relation to the public.

Topics to be covered in the Juvenile Delinquency and Dependency Section of the Institute include the utilization of social resources of the community, probation as social treatment, social case investigation and diagnosis, state and local institutional program, mental hygiene, and prevention of juvenile delinquency.

Special library service and facilities are being arranged with the General Library of the University of Southern California for reference use during the period of the Institute.

By special arrangement, privileges are to be extended to the members of the Institute by the Los Angeles Athletic Club, the Pacific Coast Club, the Surf and Sand Club, the Sunset Fields Golf course, and the Student Union on the Trojan campus. Accommodations for the week are to be provided at the Sigma Chi Lodge and the men's and women's dormitories at the University of Southern California.

Town Forests in Massachusetts

Some interesting information on what is being done by towns and cities of Massachusetts in the development of municipal forests is given by Charles Lathrop Pack, President, The American Tree Association, in a recent issue of The Military Engineer.

In Massachusetts, 79 towns have voted for town forests, making the state the leader in this work. In certain places, the land held for the protection of the town's water supply has been placed under the town forest act; others have taken the town farm for that purpose; and some have put under forest management the lands acquired by the town for the non-payment of taxes. A large number of towns have been fortunate enough to have received gifts of land to be used for town forests, and occasionally a memorial forest is established in that way. When none of those methods are feasible, the town is asked to appropriate money with which definite tracts are acquired.

In 1924, the town of Merrimac voted $950 for the purchase of thirty acres for a town forest, and seventy acres of the watershed which was already owned by the town for the protection of its water supply was also placed under the town forest act. Part of the land had been recently cut over and some of it contained a partly grown stand of hard woods. Since the establishment of the forest, all this land has been placed under forest managment and considerable wood has been sold, largely from thinnings. In that year, the Massachusetts Forestry Association planted 5,000 trees free of charge for the town as a demonstration plantation and those trees have made excellent growth. This work was continued by the town forests committee and, today, 32,500 young pines and spruces are manufacturing future saw logs. Trees for planting town forests are provided by the state and the only cost of reforestation to the towns is for the planting. Merrimac has made a good record in the management of its forest, because it was fortunate in having some wood to sell, and the net cost of the town forest to the town above the price of the land has been only $264.50.

Last spring, the chairman of the town forest committee suggested that the town might secure trees from the forest for street planting. The town has appropriated $200 for shade trees, and the tree warden found that the cost of shade trees ranged from $5 to $7 each, which meant that he could not plant more than 25 shade trees with the money available. Fifty trees, mostly sugar maples—an excellent tree for street planting—were taken from the forest and planted on the roadsides with unusual success. The town forest committee charged the tree warden only $2 each for the trees, thereby saving the town at least $100 and getting twice as many shade trees planted.

In Massachusetts, where the town forest idea first took root in this country, the proposition has been one largely of reforestation. There are only a few cases where the towns have secured land containing any considerable amount of merchantable timber. Petersham is an outstanding example where the town farm, which contained a wood lot of fine second-growth white pine, was made a town forest. This timber was sold for nearly as much money as could have been obtained by the sale of the whole farm.

At Fitchburg, which has the distinction of having established the first town forest in the United States under a state law, some of the land was covered with merchantable wood and the money obtained from the sale of forest products has practically equaled the cost of upkeep and of reforestation. The land is now completely stocked and the forest is in condition to produce more timber than before. Several other towns, such as Groton, have also made some sales of timber or cordwood, but, for the most part, the lands set aside for town forests are cut-over areas or worn-out pastures. While the town forest will serve many useful purposes in the future, such as timber production, water conservation, recreation, and as bird and game refuges, at the present time most of them in Massachusetts are in the making, containing only young growth and hence the outlay generally exceeds the income.

Much of the charm of the Massachusetts towns and waysides is found in the beautiful old shade trees planted by our grandfathers and their fathers. Those trees were taken from the nearby woods and planted by public-spirited citizens during their spare time, at a mere fraction of the cost of planting trees today. The people who loved trees in those days did not wait for the town to make an appropriation to do the planting, they grouped together and did the work with their own hands. At one period, tree-planting societies were organized throughout the Commonwealth, and to those organizations we owe much of the arboreal beauty of our cities and towns. The same thing can be done today. Civic, trade, booster and fraternal organizations numbering hundreds are now in existence throughout the Commonwealth.

It is easy to see the educational value of the town forest program and the results obtained. The town forest can be used to take up labor slack; it provides work and at the same time a playground. The town forest would show the value of a timber crop every year.